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THE NEW OBSERVATORY AT NICE.

THE accompanying engraving, from a sepia drawing by Mr. Garnier exhibited at the museum of the Paris Observatory, gives a general view of the Nice Observatory, situated on Mont Gros, at a distance of three miles from the city.

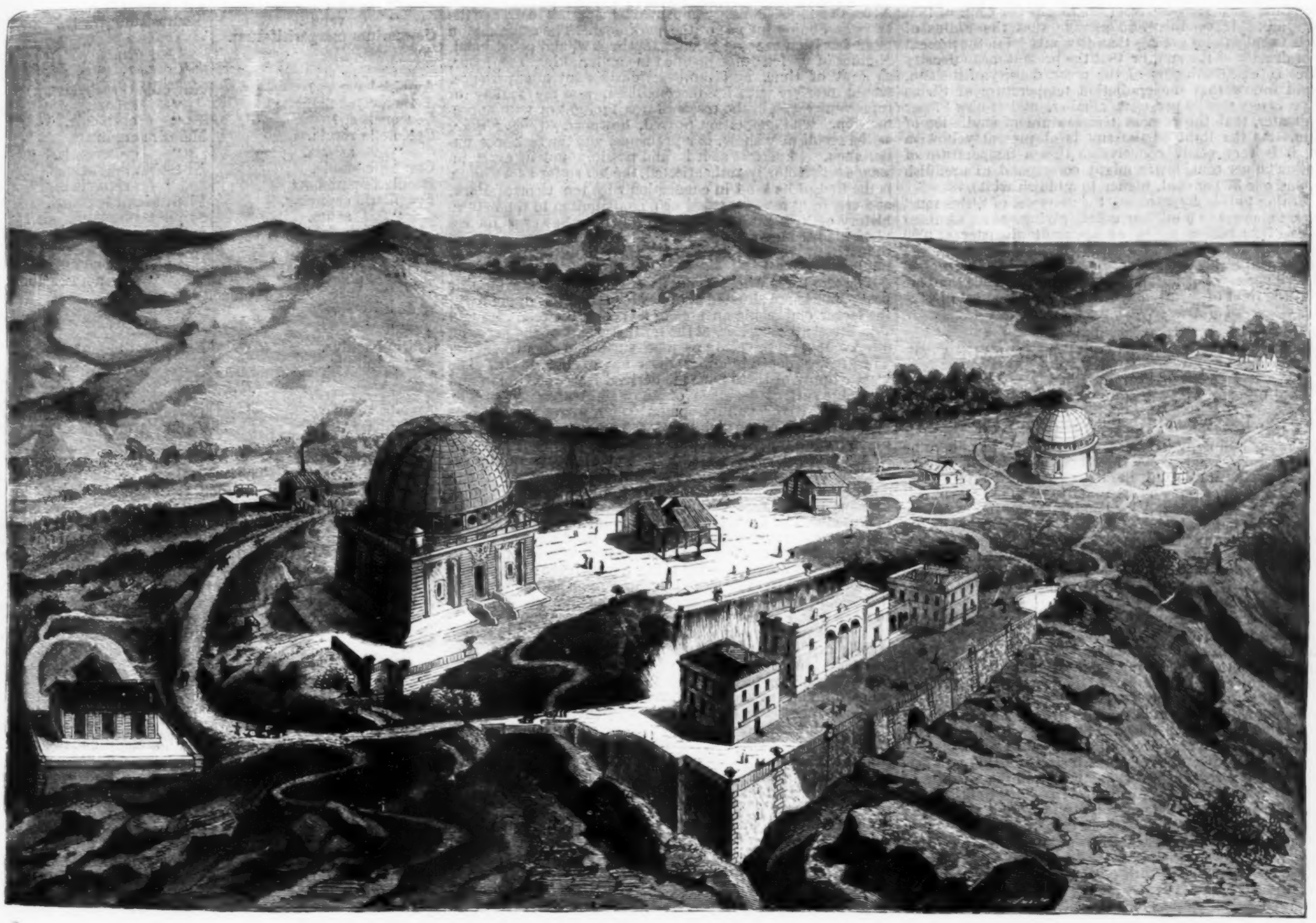
The honor of founding this important scientific establishment is due to Mr. Bischoffshein, who liberally furnished all the funds necessary for the purchase of about seventy-five acres of ground, for the construction of cottages, and for the purchase of instruments, and who thus made the state a present of nearly six million dollars.

The buildings were erected after plans by Mr. Garnier, the eminent architect of the Paris Opera House.

The observatory is provided with a collection of astronomical instruments befitting the progress of modern science, and includes a 14-inch equatorial and a large 28-inch one, constructed by Brunner, and various magnetic meteorological and registering apparatus.

The establishment is completely organized, and important scientific work has already been done therein.

The director is Mr. Perrotin, a distinguished astronomer, who has successively belonged to the Toulouse and Paris Observatories, and who recently signalized himself as head of one of the missions for observing the transit of Venus. Associated with him is Mr. Thollon, a physicist well known through his fine spectroscopic studies.—*L'Illustration.*



THE NEW OBSERVATORY AT NICE.

ON THE CONSTITUTION OF GASEOUS HEAVENLY BODIES.

PROF. A. RITTER has been engaged with certain investigations relating to the period of development of the fixed stars, the color of the twin stars, the entire duration of the visible existence of the fixed stars, and the present condition of Sirius. He remarks, in the *Naturforscher*, that the whole duration of the visible existence of a fixed star is divided into three periods of unequal length by the culminating point of its heat-radiation (or the epoch of its greatest brightness) and the culminating point of its eradiation temperature, or that epoch in which the color of its light approaches most nearly to the blue extremity of the spectrum.

During the first period the eradiation of heat was continually on the increase. At the beginning of this period, when the star is still in the condition of a nebulous spot, this change of state takes place very slowly, since at that time the emission of heat was very small. Subsequently it is much accelerated, when by increasing density the eradiation of heat reaches its culminating point.

During the second period the eradiation of heat is already decreasing, while the temperature of radiation is still on the increase. The speed of the change of condition is at first great, and becomes subsequently gradually less when the temperature of eradiation reaches its maximum value.

During the third period both the heat-radiation and the temperature of eradiation are constantly diminishing, and during this entire period the change is very slow.

With reference to the second stage of development, the author has shown elsewhere that the relative speeds of the changes of condition of two fixed stars are as their masses. The duration of the transition of a fixed star from the culminating point of the heat-radiation to the culminating point of the temperature of eradiation is approximately inversely as its mass.

The culminating point of the temperature of eradiation forms the beginning of the period of cooling, and the duration of the latter will be in any case the longer, the greater the mass of the star. For the duration of cooling of the sun, or the assumption that its contraction will proceed at least until its density is everywhere as great as the present density at the center of the earth, and supposing an equable decrease both of the surface-temperature and of the surface itself, we obtain as inferior limit a time of about 76 million years, and we may assume that during the greater part of this period of refrigeration—therefore at least during the next 40 million years—the sun will continue to send out luminous heat-rays.

The duration of the change of the sun from the culminating point of its heat-radiation to the culminating point of the temperature of eradiation amounted, on the other hand, to about 4 million years only. For a fixed star whose mass is greater than the mass of the sun there will be a greater distance between these two epochs, and as, further, only fixed stars of great mass ever reach that temperature which corresponds to the emission of a bluish white light, there results the following proposition:

The duration of the transition from a reddish to a bluish light is always very small in comparison to the duration of the subsequent return from a bluish to a reddish light.

If therefore we have two fixed stars, A and B, which simultaneously reach the culminating point of their heat-radiation, A possessing a relatively large and B a relatively small mass, A will at first outstrip B in its development, and reach the culminating point of its temperature of eradiation earlier than B. Subsequently it will again lose the advance which it had gained. During the very protracted period of cooling-down, A will again be overtaken by B in the process of refrigeration, so that B will reach the end of this period earlier than A. As A has a higher temperature of eradiation than B, and not only attains this temperature earlier than B, but retains it longer, A will at all times have a higher temperature of eradiation than B.

If therefore two such stars, which simultaneously reached the culminating point of their heat-radiation, are, for the sake of brevity, designated as "coeval" stars, we arrive at the following proposition:

Of two coeval stars, the one whose light approaches in color nearest to the red extremity of the spectrum has the smaller mass.

If both stars have a relatively low age and are at equal distances from the earth, the red star, in spite of its smaller mass, may appear as the brighter of the two, inasmuch as it is not yet as far removed from the culminating point of its heat-eradiation, or brightness—and inversely, from the greater brightness of the redder star we may infer the comparatively low age of both. As in double stars the brighter of the two is generally designated as the principal, the following proposition would follow on the supposition of the equal age of both:

If the color of the principal star lies nearer the red extremity of the prism than that of its companion, the principal is the one possessing the smaller mass, and both stars are still—if we may use the expression—in a relatively youthful stage.

During the contraction of a gaseous cosmic body, the parts belonging to the superficial stratum approach the center; and as the speed of this subsidence can never exceed the speed of a freely falling body, we may deduce an inferior limit for the duration of the nebular spot period from the assumption that the subsidence of the superficial layer during this period has always taken place with the speed of a freely falling body. In this manner we find, as an inferior limit to the time which the sun's radius would have required in decreasing from an initial value equal to about half the distance of the nearest fixed star down to the magnitude of the radius of the orbit of Neptune, or to the radius of the earth's orbit (the latter assumption giving a result which differs from the former merely in a vanishing degree), a time of about 16 million years.

As the inferior limit of the whole duration of existence of a fixed star of the mass of the sun, we should find a time of

about 60 million years, of which 16 million years belong to the nebular period, 4 millions to the transition from the culminating point of the heat-radiation to the culminating point of the temperature of eradiation, and 40 million years to that part of the process of refrigeration which corresponds to the emission of light. The real duration of the phenomenon may be considerably greater, as in the above estimate the continuous increase of mass and heat determined by the fall of meteorites has been ignored.

[It will at once strike the reader that this estimate does not agree with an earlier passage in this memoir, where the life of our sun to the end of its luminosity, and apparently including the nebular portion of its career, is taken at 76 million years. Geologists and biologists will require much more positive evidence than astronomers and physicists have yet furnished before accepting such low estimates for the age of the sun, and consequently of the earth.]

As a confirmation of the theory here put forward may perhaps be noticed the change in the color of Sirius which has occurred within historical times. That this star was decidedly red 2,000 years ago can scarcely be doubted after the accordant evidence of Ptolemy, Cicero, Horace, and Seneca. Seneca remarks expressly that the light of Sirius was more decidedly red than that of Mars. As Sirius now appears of a bluish white it would have to be assumed, according to the author's theory, that about 2,000 years ago Sirius was still in the first stage of development of red light, and that its temperature of eradiation has considerably increased in the mean time.

On the assumption of a certain mean consistence of the gas of which our sun consists, by applying the above method of investigation we should arrive at the result that its radius has required 28,150 years in decreasing from 100 times to 20 times its present magnitude, and that during this time the temperature of eradiation has risen from 21·5 to 36·8 per cent. of its present value.

As the mass of Sirius is 13·8 times that of the sun, Sirius must have passed through the same period of development in 2,040 years, and during this lapse of time its temperature of eradiation must increase from 80 to 137 per cent. of that temperature. If we therefore assume that the radius of Sirius is twenty times greater than it would be in the present state of density of the sun, or that the present mean density of Sirius is the 8,000th part of the mean density of the sun, it would follow that the eradiation temperature of Sirius 2,040 years ago was 20 per cent. smaller, and is now 37 per cent. greater, than the present temperature of eradiation of the sun. As the light of the sun is at present yellowish white, it is very easily conceivable that a temperature of eradiation 20 per cent. lower might correspond to a reddish color, and one 37 per cent. higher to a bluish white.

According to this hypothesis, the diameter of Sirius must at present amount to 9 million miles, giving, at an assumed distance of 20 billion miles, an apparent diameter of 0·09 second. It would follow also from the hypothesis that the temperature of Sirius is still increasing, and has only reached about 36·8 per cent. of its maximum value. Hence the blue color of the light of Sirius may considerably increase in the future.—*Journal of Science.*

THE FRESH WATER FLORA AND FAUNA OF CENTRAL PARK.

PRELIMINARY PAPER

By L. P. GRATACAP and A. WOODWARD.

THE fauna and flora of fresh water ponds have become more generally studied as the limits of natural history widened, as the important influences exercised upon the character of water supply by organic life became known, and as the microscope extended its conquests and improved its powers. The publication of large and more or less exhaustive treatises upon microscopic life have made the task simpler of finding out the character and names and habits of the numerous strange objects which pass before the amateur upon the glass slide, though he finds identification even then difficult, and realizes that previous experience and a long series of observations are necessary for his progress in this bewildering field of natural study.

The monograph of Prof. Rabenhorst may be said to have first opened up the field of practical examination of fresh water algæ to general students. His work entitled *Flora Europæum Algarum Aquæ Dulcis et Submarinæ* was a careful revision of the work of older authorities, and established a foundation upon which new discoveries could be established, especially as it arranged a confusing synonymy of species in previous disorder. For American students the publication in 1874 of Dr. Wood's "Contribution to the History of the Fresh Water Algæ of North America," ("Smithsonian Contributions to Knowledge," vol. xix.) was a long wished for help, and gave a real impetus to this study among many to whom special papers and widely separated notices were inaccessible or unknown.

Dr. Schweinitz's early work on the desmids of America was continued by Dr. Francis Wolle, and his lists, identifications, and descriptions are familiar to students in the Bulletin of the Torrey Botanical Club, followed only recently by his monograph on this subject, which must give the study an important impetus. The general student, in his attempts to identify the innumerable and somewhat monotonously varied species of diatoms, must depend upon the scattered publications of J. W. Briggs in the *American Journal of Science and Art*, and in the Proc. Boston Soc. Nat. Hist., of Chas. Stoddard from the same source, and of S. A. Briggs of Chicago, now of New York, in the *Lens*. The large and attractive work of Dr. Henri Van Heurck on the diatoms of Belgium forms a monograph on this subject, and the American student should possess this work or have access to it in his own researches, for the help it affords is very considerable. Assistance will be obtained in the Annual Geological Report of Indiana, 1882, in the paper and plates contributed by Rev. Geo. L. Curtiss.

The more inviting field of protozoan investigation is fortunately occupied by an exhaustive writer, and the young microscopist will rejoice in his first amazement over these extraordinary and prevalent forms, to turn to the sumptuous work of Dr. Leidy upon the Fresh Water Rhizopods of America.

Infusorial life has been treated upon with abundant elaboration and apparently* delightful literary skill and attractiveness by W. Saville Kent. These multitudinous objects, whose swarming numbers and eccentric motions early attracted the attention of observers, in old works are described as animalcula, a name which popularly still clings to them. Antony Van Leeuwenhoek in 1677 published the first account of these interesting forms, whose myriads pervade the waters about us, and his work was followed by Baker (1742), Muller (1773), and others. Veritable progress in the understanding of the real position of *infusoria* proper and in the separation of the heterogeneous group of objects included under the name of animalcula was made by Ehrenberg, Dujardin (1811), Von Siebold (1845), Stein (1854), Claparede and Lachmann (1858), Max Schultze (1860), Pritchard, and among modern authors by Haeckel, Englemann, and Butschli (*Nature*, vol. xxvii. p. 601).

The work of Mr. Kent is comprehensive to the last degree, and though his views as to the generation of infusoria and their affinities have encountered adverse criticism, his lists and descriptions of species and his figures are simply unexcelled and invaluable.

The bibliography of rotifers is quite large, and is not confined to any special work; Carpenter, Gosse, Ehrenberg, Dujardin, Pritchard, etc., having contributed to this section of microscopic study.

For the crustacea the student will find less convenient and complete works at his command. Two notable contributions, monographic in character, to this subject, have been published by Prof. A. S. Packard and C. L. Herrick. Prof. Packard's work is contained in the Annual Report of Hayden's Survey of the Territories, for 1878, part I. and treats of the subdivision of phyllopods whose forms prevail in the West and are sparingly represented in our Eastern regions. Mr. Herrick's work represents the results of careful research in the fresh water basins of his own State, Minnesota, to which he has chiefly confined his attention, principally in the groups of Cladocera and Copepoda. He has surveyed the distribution of species in the United States and has prepared generic tables for determinative study.

The "Micrographic Dictionary" is indispensable, and its descriptions, references, and plates replace to some extent the possession of the other special treatises.

In the spring of this year (1884) the writers were requested by Mr. W. A. Concklin, Superintendent of the Central Park Zoological Gardens, to make an examination of the microscopic and other life contained in the lakes of Central Park, N. Y. The request was accompanied by a permit to dredge the lakes and enjoy the use of the park boat. The examination made has been to some extent experimental and provisional. Neither of us felt fully justified in undertaking the labor, as want of time, and more seriously want of experience, would interfere with its thoroughness, and the variety of topics embraced in the research was thought of with apprehension. The temptation proved, however, stronger than, as the result may show, our prudence, and the task was undertaken. Imperfect as it is, and possibly not in every instance satisfactorily authenticated, the list so far as we know is the first of its kind in connection with the Central Park, and can be at least regarded as a contribution to the natural history of New York Island. At any rate, however incomplete the list may appear, the catalogue of papers appended to it will prove valuable, and may help to justify the paper's publication.

The two lakes whose waters were examined during this past summer are situated at opposite extremities of the park, the larger embracing an area of 20 acres, between 74th and 77th Street; the smaller, at the northern end of the park, on 5th Avenue, representing a square surface of about 12 acres. The greatest depth in either does not exceed 13 ft. The water supply of these ponds is derived from the Croton and from the surface drainage of the neighboring slopes; the roadways, drives, and foot-paths which arrest a great part of the rainfall in the vicinity of the lakes are drained into underground pipes, which again empty in the lake. The lakes are stagnant ponds, and the water is foul and impotable. The larger and more southern lake is tenanted with aquatic fowl belonging to the park gardens, and they must to some extent arrest the multiplication of crustaceous, molluscous, and fish life. The various inlets, sinuosities, and bays along the shores were found to be good hunting places, and we adopted the use of a surface net, which brought us many species not discovered along the margins of the pond. This net was a shallow sieve of coarse linen attached to an iron hoop; the whole suspended from the stern of the row boat, and pulled through the water at a distance of 16 or 20 feet from the boat itself, filtered the inrushing tide, which also kept it inflated and gathered a film of algæ (oscillatoriæ) in its pores, which in turn entrapped and retained associated forms. This film was washed off into a saucepan, and the washings poured into settling bottles, from whose sediment the material for microscopic examination was obtained. Dredging was resorted to upon Harlem Lake (the upper lake), but it did not reveal any molluscous life, though the silt drawn up contained numerous diatoms.

Our examination has not revealed as many varied forms of life as we had expected, and among the algæ we have failed to detect forms considered as more or less prevalent in the Croton water. A noticeable absence of desmids and rhizopods was something of a surprise, as also the deficient representation of algæ. One form of oscillatoria (Ochlorina), however, filled the waters of the lower lake at every point, and its waving and crowded filaments produced a turbid and flocculent appearance that is curiously deceptive, resembling clouds of some impalpable precipitate in the water. Among the threads of the oscillatoria were scattered chains of anabæna and nostoc. Spirogyra in limited and depauperate colonies were found near the shore, and braids and collections of a stigeoclonium-like algæ elsewhere.

Desmids are strikingly absent in our collections, but these may be discovered by later examinations. It seems probable that the stagnant, offensive state of the water may exercise an injurious influence on the multiplication of these objects, and the deficiency of fresh water hasten their death and decomposition when introduced. The diatoms are comparatively numerous, and found in numbers among the clusters and knots of algæ moving and disseminated through the surface waters, and entombed in the mud of the bottom. The infusoria in numbers exceeded all other objects, though the species enumerated are not many. These will be extended in future examinations. These puzzling creatures have given us great entertainment, and representing the nucleus of that ill-defined and chaotic assortment of objects known as *animalcula* will have in later and fuller lists more attention paid to them, as their identification has been rendered more possible by the extended treatise of Saville Kent.

The crustaceæ were strikingly few in species, though in some spots abundant in numbers; cyclops, cypris, daphnia, being prevalent and widespread.

Rotifers were frequent; vermes were found on sticks and through the algæ, and the species of larva indicated was seen associated with a new species (?) of spongilla to which in the list we have appended a note. Among micrococci, *Vibrio bacillus* and *V. spiralis* abounded in certain places where there seemed unmistakable evidence of sewage contamination. These were seen in conjunction with whirring and infinitesimal objects, which in immense numbers were lashing themselves through the clustering mass s of their neighbors, and which were believed to be *Bacterium termo.*

The species of mollusca have been almost entirely confined to Harlem Lake, *Physa heterostropha* and *Planorbis parvus* excepted. They were not numerous, but were encountered along the shores at various points, and all belong to shore feeding species. The anodontas were found mostly represented by dead shells, but one living specimen of A. fluviatilis was taken. Their habitat seemed to be near and under the wooded banks of the pond. We are indebted to Mr. Concklin for the lists of fishes, and we owe to Mr. Sanderson Smith acknowledgment for identifications among the mollusca.

* The writers do not possess as yet a copy of this expensive work, though they will soon doubtless have access to it.

FLORA AND FAUNA OF THE TWO LARGER FRESH WATER LAKES OF CENTRAL PARK, N. Y.

Provisional list made in 1884.

ALGÆ.

Confervoideæ.

Oscillatoria chlorina.
" nigra.
" Fröhlichii.
Conferva sp. (?) stigeoclonium (?).
Nostoc sphæricum.
Anabæna flos-aquæ.
" gigantea.
Spirogyra diluta.
Batrachospermum moniliforme.
Cœlosphærium dubium.
Sphærium sulcatum.
Botryococcus Braunii.
Protococcus sp?
Polyedrium spinosum.
Spirulina Jenneri.
Palmoglæa macrococca.
Palmella hyalina.
Scytonema sp?
Chantransia expansa.
Scenedesmus quadricauda.
" polymorphus.
Volvox globator.

Desmids.

Closterium Ehrenbergii.
" griffithsii.
" venus.
Cosmarium margaritiferum.
Hyalotheca dissiliens.
Pediastrum boryanum.
Staurastrum gracile.

Diatoms.

Amphipleura sp?
Actinocyclus niagaræ.
Cocconeis sp?
Cyclotella rotula.
" astræa.
Cymbella affinis.
Bacillaria paradoxa.
Fragillaria capucina.
" acuta.
Licmophora flabellata.
Navicula sp?
" rhynchocephalus.
" placentula.
Navicula rhomboides.
" inflata.
" cuspidata.
Melosira crenulata.
" crotonensis.
Nitzschia longissima.
" sigmoida.
Pleurosigma spenceri.
Stephanodiscus niagaræ.
Synedra capitata.
" ulna.
Gomphonema constrictum.
" acuminatum.

Protozoans, etc.

Schizomycetes.

Vibrio bacillus.
" spiralis.
Bacterium termo?

Rhizopoda.

Amœba proteus.
Actinophrys sol.
Cochliopodium bilimbosum.
Difflugia urceolata.

Spongida.

Spongilla fragilis? The specimen which was identified as this sponge was gathered upon the surface of rocks in a stream of artificially supplied water, tributary to the Harlem Lake. It was sent to Prof. E. Potts, of Philadelphia, who kindly acknowledged it, and said that the weight of evidence was in favor of Spongilla fragilis, but the absence of statoblasts prevented any entirely satisfactory identification.

Spongilla? sp? This specimen, which caused us considerable perplexity, and which may be quite wrongly classified, was found attached to sticks of *rubus*, floating in the water, in the form of low spine-like projections in groups, which under the microscope were seen to be composed of hollow needles irregularly blotched with brown patches, and quite densely hispid with hairs of various lengths, which seemed fascicled. These needles or tubes were irregularly lobose and swollen at points, and seemed striated. The slender ends were terminated by long flagellum-like hairs. Among these moved a vermiform larva with a mop-like head of recurved hooks at one extremity.

Infusoria.

Cothurnia sp?
Coleps hirtus.
Chilodon cucullus.
Euglena viridis.
Halteria grandinella.
Heteromita ovata = Bodo grandis.
Kerona pustulata?
Monas umbra.
Paramæcium caudatum.
" aurelia.
Stylonichia histrio?
Trachelomonas sp?
Vorticella microstoma.
" sp? free swimming, perhaps Trichoda.

Rotifera.

Anuræa stipitata.
Chætonotus squammatus.
Colurus deflexus?
Euchlanis triquetra?
Noteus quadricornis.
Notommata centrura.
Rotifer vulgaris.

Vermes.

Anguilula fluviatilis.
Nais sp?
Hirudino—two species.

Crustacea.

Asellus vulgaris.
Bosmina longirostus.
Chydorus sphæricus.
Cyclops quadricornis.
Cypris fasciata.
Daphnia pulex.
" sp?
" reticulata.
Gammarus fasciatus.
Sida crystallina.

Probably Gammarus minus and G. limnæus will be found.

Bryozoa.

Statoblasts of Plumatella have been indicated to us by Prof. E. Potts, but as yet no colonies of the mature organisms have been found.

Mollusca.

Anodonta fluviatilis.
" implicata.
Amnicola granum.
Limnæa columella.
" humilis.
Physa heterostropha.
Planorbis deflectus.
" parvis.
Succinea ovalis.
Limax campestris.

Pisces.

This list was furnished by Supt. W. A. Conckiin.

Catfish, Amiurus melas.
Gold fish (carp), Cyprinus auratus.
Sun fish, Lepomis gibbosus.
White perch, Rocco americanus.
Yellow perch Perca americana.
Eels, Anguilla.
Killifish, Fundulus.
Common sucker, Calostomus commersoni.

The above have all come through the water pipes. The following have been placed in the ponds:

German carp, Cyprinus carpio communis.
Black bass, Micropterus salmoides.
Speckled trout, Salvelinus hoodi.
Tench, Tinca vulgaris.

Chelonia.

Chrysemys picta, abundant. Chelopus guttatus.

EXAMINATION OF BREAD AND FLOUR.

OF foreign substances sometimes found in bread and flour we mention secale cornutum, spurred rye, agrostemma Githago, gith; and of adulterations, gypsum, heavy spar, alum, copper, and zinc sulphate. Some of the enumerated products, especially spur and gith, are readily detected by means of the spectroscope. The sample of flour tested for spur according to Wolff, is first treated with ether and then with a mixture of ether and sulphuric acid, the latter being used in proportion of 15 to 5. The presence of spur renders the filtrate red, and produces two spectroscopic bands situated between D and E, and *b* and F, accompanied by a shading in blue. Petri employs as solvent alcohol acidulated by sulphuric acid, or amylic alcohol or chloroform; each of these solutions exhibits in the spectroscope the characteristic absorption bands ranging from D to E, E to F, and F to G. On repeating examinations by these methods, Prof. Uffelmann became convinced of the necessity to replace them by a method more adapted for the detection of minimal quantities of ergot. As menstruum he employs a dilute solution of caustic soda obtained by adding 6 c. c. soda lye of 1·33 s. g. to 100 c. c. distilled water. On mixing 10 parts of flour with 100 parts of the alkaline liquid, and filtering after two or three hours, a red filtrate is obtained which, placed in a thin glass tube of 2 to 4 cm. in width, yields a dark zone in the spectrum, extending from blue to D, with maximal intensity at D to D $\frac{1}{2}$ F, and at E to E $\frac{1}{2}$ D. Addition of concentrated muriatic acid in excess to the alkaline liquid renders the color pale red. The pigment is readily separated from the acid solution by ether, to which it imparts a dark red coloration. The ethereal solution of ergot is distinguished by two absorption bands; the one between D and E, ranging from 57 to 63 when D coincides with 50, is similar to that produced by an aqueous solution of fuchsine; and the other, visible at *b* and F, extends from 80 to 85. This method admits the detection of 0·125 per centum of ergot, and thus suffices all practical application. Detection of a small percentage necessitates the use of a wide glass tube from 7 to 10 cm. in diameter, the employment of a small measure of ether, and immediate examination of the filtrate. The method has the advantage that it exhibits most distinctly the chemical reactions, and thus excludes the possibility of error; no other substance contained in flour or bread imparts to the filtered liquid a red color or possesses the spectroscopic behavior described above. Alcohol or ether dissolves chlorophyl, which obscures the spectroscopic examination of ergot, as the ethereal solution of chlorophyl produces an absorption band similar to that obtained by a solution of ergot in ether. Chlorophyl is dissolved by an alkaline solution; with a yellow-green color, which is totally destroyed on addition of sulphuric acid. For the examination of spurred rye in bread, the material is comminuted, exhausted with 50 c. c. of the alkaline solution, acidified with muriatic acid, and shaken with ether as before. The seed of agrostemma Githago, or gith, is detected by the following method: Flour or comminuted bread is mixed with a dilute solution of caustic soda; the mixture is boiled and filtered. Continued heating of the fawn-colored filtrate renders it copper-red, and finally yellow; after the appearance of the red coloration it is rapidly cooled down, and then examined by means of the spectroscope. A well defined absorption band, situated between D and E, with maximal intensity toward D, similar to that produced by a solution of ergot, is produced. The absence of the second band readily distinguishes it from the latter. The red liquid obtained by boiling is changed to yellow on introduction of muriatic or acetic acid; amylic alcohol or ether exhausts the acid solution from its pigment, while the alkaline liquid retains it when treated with these reagents. Solution of the pigment in amylic alcohol causes a partial absorption ranging from the border of blue to *b*; addition of caustic potash in excess gives rise to a violet or red coloration; and produces an absorption band between D and E. The detection of alum in flour or bread renders a previous incineration necessary; the obtained ash is examined upon alumina, or the aqueous filtrate of flour or bread is treated with a few drops of a concentrated aqueous solution of logwood. The first method yields reliable results, but demands care and skill; the second, when verified by spectroscopic examination, is well suited for practical application. The modus operandi is the following: Flour or bread, after previous desiccation of the reduced fragments, is mixed with pure water in proportion of 1 to 10, the mixture is well stirred, filtered, and, when of acid reaction, treated with a slight excess of sodium carbonate. A few drops of an aqueous logwood solution, introduced to one portion of the filtrate, turning it bluish or violet according to the quantity of alum present, cause the formation of two spectroscopic bands ranging from D to *d*, and from D to D $\frac{1}{4}$ E. When the result obtained is doubtful, another portion of the filtrate is concentrated to one-quarter of its volume, or still further, filtered, and re-examined as before. The method determines with certainty minimal quantities of alum. Presence of copper sulphate affects the alkaline solution of logwood; it is therefore necessary to establish the absence of the copper salt by preliminary examination of the filtrate with potassium ferrocyanide or ammonium hydrate.

THE REMOVAL OF TATTOO MARKS.

INDIA-INK markings in the skin are often the source of much annoyance in after life to those who have been tattooed in youth. The editor of the *Medical Press* states that nothing but the knife or an active escharotic will produce a satisfactory result. He holds that the cutis must be destroyed. Dr. Neale, of London, however, claims that he has secured good results with sodii ethylas, first suggested by Dr. B. W. Richardson. He cites the case of a gentleman who, in his younger days, had a palm tree tattooed on his arm and an elaborate bracelet on his wrist, who has quite lost all the dark matter, etc., the skin being left in many places quite natural, although, of course, there is still more or less of a scar, but this diminishes month by month.

PASTEUR ON THE PREVENTION OF HYDROPHOBIA.

THE eighth International Medical Congress assembled in Copenhagen, Aug. 10, 1884, and was attended by many prominent medical men from all parts of the world.

The paper read by Professor Pasteur on Pathogenic and Vaccinia Microbes seems to have been the one to which most interest was attached during the Congress. Pasteur's speech was principally a report of the work done in his laboratory during the last four years. His own and his pupils' labor has been entirely devoted to the question of hydrophobia inoculation, and his experiments have been both numerous and thorough. As the results of some of these have already been published, only a brief summary of the first part of the speech can be given. He first called attention to the fact that the characteristic changes of the tissues in animals which had died from hydrophobia are often limited to the medulla oblongata, in which organ the poison producing the disease is found most concentrated and pure. Secondly, to the fact that inoculation of the poison obtained from the medulla oblongata is not always followed by positive results, unless the poison is introduced into the subarachnoid cavity by means of a trocar, after trepanning the skull has been performed.

These two facts have been of vast importance in solving the great difficulty in obtaining the poison sufficiently concentrated for experimental purposes, experience having shown that two dogs, both bitten by the same rabid dog, may take the disease in quite different degrees and after longer or shorter periods of incubation. Liability to error may, however, be obviated by pursuing the following method: Take the medulla oblongata from a dog which has died of rabies, crush and put it into sterilized bouillon, taking all necessary precautions. By introducing two drops of this preparation into the subarachnoid cavity of rabbits by means of a Pravaz syringe, the same results will always be produced; the rabbits will all develop hydrophobia within twelve to fifteen days, neither more nor less. It is, however, necessary to take the poison from dogs while the disease is at its maximum, otherwise the period of incubation will be very different.

By transferring the poison, originally taken from a dog, from one rabbit to another, from a second to a third, and so on, Pasteur has come to the result that after the tenth inoculation the incubation period is reduced to from eight to nine days. After this point the incubation period is of exactly the same length until the fifteenth inoculation, which during the last few days he has succeeded in reaching. Guinea-pigs reached the incubation period proper to them after a shorter series of inoculations, but neither in these animals nor in rabbits or dogs is it possible to weaken the poison by inoculation. Pasteur has, however, succeeded in finding animals in which it is possible. The latter part of the speech was as follows:

Jenner first propounded the idea that the poison which he called "grease," but which we now more accurately call horse-pox, must, before it can be given to man without danger, be weakened in its poisonous effect, if I may use the term, by being transferred to the cow.

After this the idea of weakening the hydrophobia poison by introducing it into certain animals seemed worthy of a trial. Many experiments were made, but in the greater number of animals experimented upon the poison only increased in virulence, as, for instance, in rabbits and Guinea-pigs; happily monkeys proved an exception. On the 16th December, 1887, a monkey was inoculated by trepanning from the medulla oblongata of a dog, whose rabid state had been confirmed by the fact that it had bitten a child who afterward died of hydrophobia. The monkey became mad eleven days after. From this one the poison was given to a second monkey, which also became mad in the course of eleven days. A third monkey was only attacked after twenty-three days. From the medulla oblongata of each monkey two rabbits were inoculated. The rabbits inoculated from the first monkey were seized after thirteen and sixteen days, those from the second monkey after fourteen and twenty days, those from the third after twenty-six and thirty, those from the fourth after twenty-eight, from the fifth after twenty-seven, and from the sixth after thirty days. It cannot be doubted after this that by transferring the poison from monkey to monkey and from several monkeys to rabbits, it at last became weakened.

In the same way it is weakened in dogs. A dog which was inoculated from the fifth monkey had an incubation period of fifty-eight days, although the inoculation was done by trepanning. Other experiments of the same nature led to like results. Thus, we are now in possession of a method by which the contagious power of hydrophobia is weakened. Inoculations from monkey to monkey produce a poison which, when given to rabbits, has an incubation period which gradually increases in length. If, on the other hand, the poison is given to a succession of rabbits, it becomes subject to the law already mentioned, by which it increases in violence when transferred from one rabbit to another. From the application of these facts we obtain a means of inoculating dogs against hydrophobia. As a starting point is taken a rabbit poisoned from a monkey, which has been inoculated by poison that has gone through so many individuals that it is not able to cause death through hypodermic or intravenous injection.

Having now applied this method for protecting dogs against hydrophobia, and having collected a large number of dogs which had been made impervious to infection, I determined, as I had a higher aim in view, and remembering the opposition which Jenner had encountered, to place the results, which, in my opinion, are the ground plan of the protection of dogs against hydrophobia, before a competent commission. The Minister of Education, M. Tallières, to whom I spoke on the subject, was willing to support me, and he appointed MM. Béclard, P. Best, Bouley, Tisserand, Villemin, and Vulpian to examine the facts which I had already laid before the Academy of Sciences at its meeting of the 19th of May last.

The Commission, having chosen M. Bouley as president, and M. Villemin as secretary, at once set to work, and I have the pleasure to announce that it has within the last few days sent its first report to the minister. The Hydrophobia Commission has up to the present experimented on thirty-eight dogs, of which nineteen were from me, and declared to be impervious to contagion, while nineteen were unvaccinated. Those dogs which have not died under treatment are still under observation, and will be for some time to come. As far as the condition of those dogs which have been experimented upon is concerned, of the nineteen unvaccinated, three out of six of those bitten have become mad, five out of seven of those inoculated in the popliteal vein have become mad, and all of the five which were inoculated by trepanning have become mad, while not one case of hydrophobia has declared itself among the nineteen vaccinated dogs.

One vaccinated dog died on July 13 from hæmorrhagic diarrhœa, which had shown itself in the first days of July. In order to see whether hydrophobia had had any part in its death, three rabbits and one Guinea-pig were at once inoculated by trepanning from its medulla. These four animals are still in perfect health, which is a certain proof that the dog did not die of hydrophobia, but of an ordinary disease. The next report from the commissioners will treat of the history of twenty dogs, the inoculation of which they will superintend themselves.

Pasteur's speech was received with enthusiastic applause.

HOW TO DISPOSE OF HOUSE SEWAGE.*

By M. T. CLARK.

IN regard to exterior drainage, particularly for country houses, since that of city dwellings requires little thought on the part of architect or owner, the last few years have witnessed a rapid development of the practice of doing away with that object of the sanitarian's particular hatred, the old-fashioned leaching cesspool. In one or two towns, where public sewers have been provided, the use of such cesspools, whether new or old, has been summarily forbidden, and, even where there are neither sewers nor health regulations, the sense of the unwholesomeness of a soil saturated with filth has become quite generally diffused in the community. In places without sewers, the only practicable alternative to the use of cesspools is the utilization of house wastes on the land, particularly by the system known as subsoil irrigation, and in some towns this has become quite common.

As the subject is a very important one to persons living out of the reach of sewers, it may be worth while to mention the modifications which have taken place in the practice of this system since its first introduction. Even now, the mode of applying it varies in nearly every case, but something, at least, has been learned from experience. Ten years ago, as those who have read the works of the most enthusiastic advocate of the system will remember, it was customary to provide houses in which it was to be applied with two drain-pipes, one taking the more purely liquid wastes, which were discharged over a Field's flush-tank, usually buried in the ground near the house, and the other carrying such drainage as might contain solid or semi-solid substances, which could not be passed through the flush-tank. This drain joined the drain from the flush-tank at some distance from the house, and both then proceeded together to a tight brick cesspool or settling basin, of twelve or fifteen hundred gallons capacity. A pipe from this settling basin, usually 4 inches in diameter, was led to some part of the ground about 15 inches below the surface, and there began to throw off laterals, consisting of round drain-tiles, 2 inches in diameter, with collars over the joints, all laid about 12 inches below the sod. From 500 to 1,000 feet of these were put in for an ordinary dwelling-house, in lines 3 or 4 feet apart, the main 4-inch pipe being carried out far enough to supply the whole system.

This method, as described in books still popular, has not proved entirely satisfactory. The old flush-tanks were expensive, and the siphons which formed a part of them soon became clogged with grease, and had to be taken up frequently, and the grease melted out, while the open grating over which the waste-pipes discharged was anything but pleasant to sight or smell. The pipes with collars over the joints also proved unsuitable. The collars fitted so closely that the sewage liquids, on their way out of the joints into the ground which was to absorb them, left solid particles of that curious black sediment which forms in sewage, entangled between the collar and the pipe, and this obstruction rapidly increased, until the flow was stopped at that joint, when the same process was repeated at the next. The trouble with the flush-tanks was the most serious one. The object of using them is, of course, to give an intermittent discharge, by which the liquid from the settling tank is sent forcibly into the outlet-pipes, and through their joints into the ground, and this is a very desirable one; but in my own practice, after struggling with a flush-tank for a year or so, it was finally cut out and abandoned, and the sewage has been disposed of for five or six years since with much less trouble than before, while in another case, where, on account of this experience, no flush-tank was put in, and only one drain for the whole house, the irrigation-pipes have done their duty faithfully for five years without giving any trouble beyond a single stoppage in the main outlet, a few feet beyond the settling tank, which was, or could have been, remedied in fifteen minutes. In this instance the round pipes were used, but without collars, the pipes being simply laid end to end, with an interval of a quarter of an inch between them, and, as I recollect, a bit of paper laid on each joint to prevent the earth from falling in and obstructing the pipe. It is often said, and not without reason, by engineers, that a subsoil irrigation system without flushing apparatus is sure to choke rapidly; but this particular set of pipes has worked so long and efficiently in a soil so compact that the leaching cesspools of the two neighboring houses, built at a cost nearly as great as that of the irrigation system, began to overflow in six or seven months after they were put into use, that the experiment cannot be considered very dangerous, and the saving of the expense and care of the flush-tank is an important matter for most families.

The flushing system is now, however, somewhat modified, so that it gives much less trouble in use, and there is, of course, an advantage in being able to apply the flushing action for preventing sediment in the pipes. In order to secure this result in a way which should be at once less expensive and less troublesome than the siphon, I had occasion a year ago to try an experiment which resulted favorably, and as it is, if not the latest improvement, at least the latest modification in the subsoil irrigation system, I hope it is not necessary to apologize for explaining it. Briefly, the flushing apparatus, instead of a siphon, consists of a tumbling-tank, that is, a tank so shaped as to overturn when filled with water, recovering its balance as soon as emptied. This is set in a tight cesspool of brickwork in cement, occupying one corner, as shown on the diagram, and separated from

* Abstract from a paper read before the Society of Arts, Boston, October, 1884.

the main part of the cesspool by a partition wall, which is built on a flagstone, set in the walls of the cesspools as they are laid up. An ordinary stoneware T is built into the little partition wall, the lower end dipping always below the surface of the water in the cesspool to avoid taking in floating grease, while the upper end is open to facilitate cleaning, and the branch projects through the wall and overhangs the tumbler tank. Just above the flagstone which forms the bottom of the tank compartment, a number of 2-inch sole tiles are built into the brickwork. These form the upper ends of as many lines or irrigation pipes, which diverge like an irregular fan from the cesspools. The whole is covered with flagstones. The cesspool holds about 1,200 gallons, so that all the matters which get into it dissolve and settle before passing into the tumbler-tank. While any plumbing apparatus in the house is used, the waste water running into the cesspool makes its overflow into the tumbler-tank, which, when full, overturns, throwing its whole charge directly into the mouths of the irrigation pipes. These pipes, which are all 2-inch sole tile, were not laid, as is the best, but most expensive, way, in permanent channel tiles, but were simply placed in the bottom of the trenches, with a bit of asbestos passed over the joints, instead of the earthenware caps used where the cost can be afforded. The whole has continued to work perfectly until now, and the tumbler-tank shows no sign of deterioration. The advantages of the system seem to be its cheapness and simplicity, the spacious water-way everywhere, so that no obstruction can take place in the apparatus, and the accessibility of all the outlet pipes. Where these are laid as branches from a main stem, it is often necessary, when they show signs of clogging, to dig up the main line in order to obtain access to the laterals, which can then generally be washed free, without disturbing them, by a good stream from a hose; but by this modification the laterals are directly accessible, by taking the covering stone off the little compartment and lifting out the tank, without any digging outside. In the same way, the tumbler-tank and the compartment in which its works can be washed perfectly clean with a hose, or a few pails of water, without disturbing them, or interfering with their action, and in fact the whole system, with the exception of the cesspool itself, can be cleaned, repaired, or even renewed entirely, without stopping the use of any of the house plumbing for a moment. The cost of the brick cesspool is something like sixty dollars, which is about the same as that of a leaching cesspool suitable for disposing temporarily of the same amount of waste; the tumbler-tank made of galvanized-iron, with brass bearings, costs perhaps fifteen dollars; the outlet pipe costs two cents a foot, or ten dollars for the minimum amount which it is safe to use for a dwelling furnished with a bathroom, and the laying costs about as much more. These items constitute the whole expense, and bring the system within the means of every one. In fact, the cost of cleaning out a leaching cesspool of the same capacity, according to the experience of my neighbors, makes that in two or three years the more expensive apparatus of the two in actual outlay. Since my experiment, the same system has been introduced, as I believe, in about a dozen other places, and, so far as I can learn, with successful results.

EXPERIMENTS IN GASEOUS COMBUSTION.

AMONG the papers read at the recent meeting of the British Association, at Montreal, was one before Section B (Chemistry) by Mr. Harold B. Dixon, M.A., F.C.S., etc. The phenomenon of the burning of carbonic oxide in oxygen or atmospheric air has hitherto been looked upon as merely a direct combination of carbonic oxide with the oxygen to form carbonic acid; but Mr. Dixon proves the incorrectness of this view. A perfectly dry mixture of carbonic oxide and oxygen does not explode when an electric spark passes through it. The presence of aqueous vapor or steam is needful to effect an explosion; the steam, by a series of reductions and oxidations, converting the carbonic oxide into carbonic acid. With increasing quantities of aqueous vapor, the rapidity of the inflammation increases. The velocities of explosion under different conditions of moisture, pressure, and temperature were determined by the author by means of the chronograph.

THE ANTIQUITY OF MAN.*

By EDWARD CLODD.

NUMEROUS as have been the discoveries of unground stone tools and weapons, which are characteristic of the Paleolithic Age, in the valleys of the Thames, Lea, and other rivers, there had been, until the fall of last year, no fragment of man's skeleton found which could be referred to that remote period.

Various satisfactory reasons for this absence of human bones are adduced; among others, the absence of bones of other animals of corresponding size, the liability to decay, or, if not burned, to being devoured by the hyenas which then abounded. But none the less was some evidence desired which might enable us to know what were the physical features of these chippers of flint.

When, therefore, in the judgment of such an expert in paleontology as Sir Richard Owen, the remains of a veritable man of the Ancient Stone Age have been unearthed, the interest of the volume before us, describing and illustrating the subject, is manifest. It would seem that in the course of some excavations at the East and West India Dockworks, at Tilbury, in October, 1883, portions of a human skeleton were found at thirty-four feet below the surface in a bed of sand; and although these were more or less detached, and, in the case of the pelvis, smashed by the navvy's pick and scattered by the shoveler, enough was recovered by the care of Mr. Donald Baynes, the company's engineer, for transmission to Sir Richard Owen. He identifies them as having belonged to a male, the jawbone indicating, by the loss of masticating teeth, that he had reached, what was probably then exceptional, old age. In a technical description, which thinly veils its humor, Sir Richard says: "The smooth, unbroken surface of the molar tract tells plainly that the aged paleolithic individual went on laboring for his subsistence long after the loss of his grinders, and putting such few teeth as remained to their utmost powers of trituration."

With his heavy polished flint weapons he had slain the mammoth or captured it in a pitfall. In the days of his youth, "iron-jointed, supple-sinewed," he had chased the deer, the bison, and other wild beasts that roamed through the thickets then covering the site above which Westminster Abbey and the Tower of London stand. During the short and special seasons of the variable climate of that epoch his dainties would be the crab-apple, the sloe, the hips, and haws; while for winter store, hazel-nuts, beech-nuts, and acorns would be gathered. But as eye grew dim and natural force abated, "the preparation for swallowing raw and hard fruit polished off the crowns of the few remaining teeth of the ancient, probably primitive, dweller of the Thames valley."

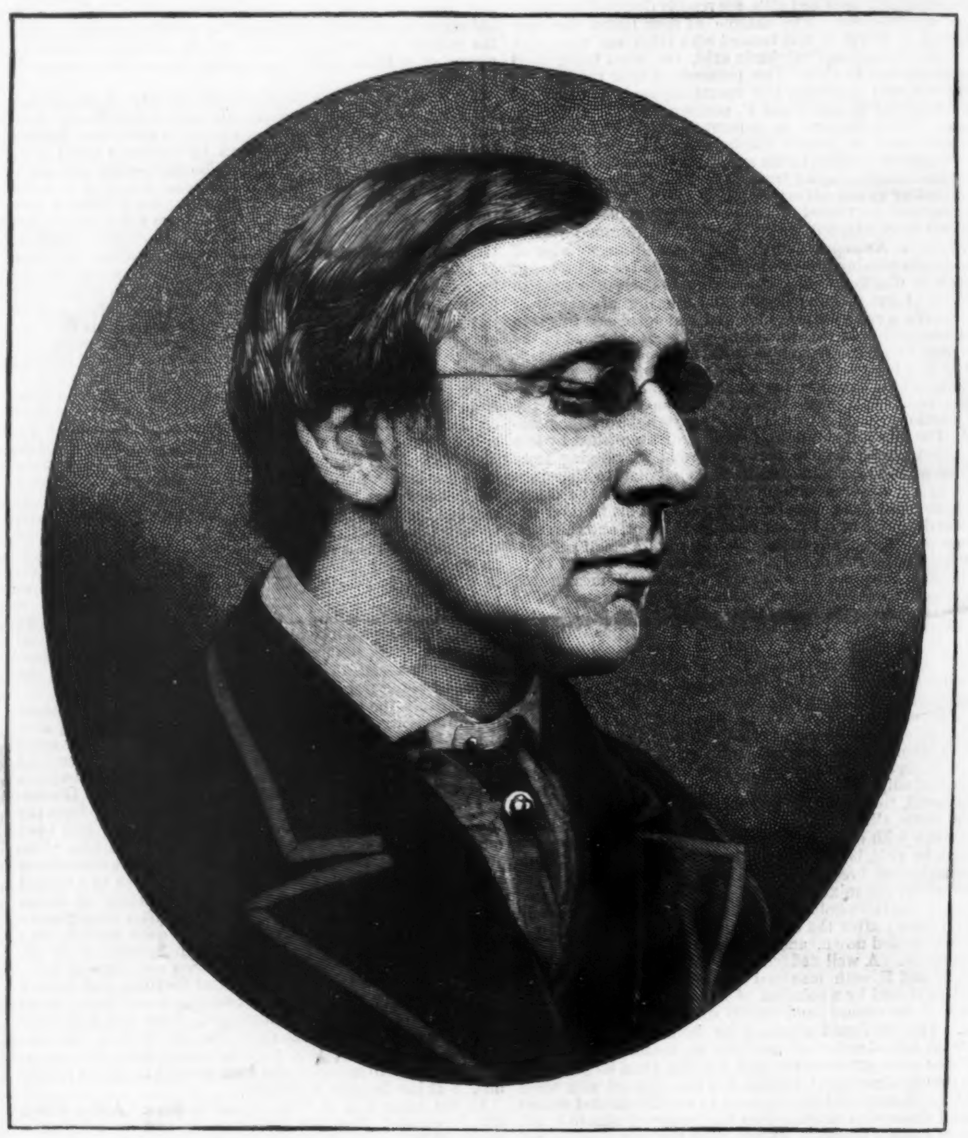
The report which Sir Richard Owen gives concerning the cranial capacity of this specimen is of value, although it affords no clew to connect it with any existing race, such as, according to Professor Boyd Dawkins, we have to connect the cave-men of the Old Stone Age with the Eskimos. In shape, the skull approaches the dolicho-cephalic, or long-headed, and "the contraction and slope of the low and narrow forehead and the prominence of the frontal sinuses are matched by low Australian and Andamanese skulls," while the eminences and depressions indicative of cerebral convolutions are few and feebly indicated. As the higher the animal, the more complex, more numerous, and irregular are these creases or convolutions, the skull of this paleolithic man is of the character we should have expected, and like indications of brute force are given by the rest of the skeleton in the contrast of strong muscular characters with the low cerebral ones.

The bones had derived a dark brown color from the powdery sand in which they were embedded. Below this is the gravel known as "ballast," and above it are successive layers of thirty feet in thickness, the time of deposition of which is the measure of time from Drift-man until now. The present level of the surface of the banks of the Thames is about the same, geologically speaking, as it was when it was forded at Corday-Stakes by the second batch of Roman invaders (52 B.C.), and the different and various soils from surface to sand have laid down tranquilly in keeping with that uniformity of causation which excludes theories of rapid or violent action. In the stratum just above the sand, fragments of decayed and blackened wood were found, showing the existence of vegetation long ago embedded in the overlying mud. Above this, beds of peat, mixed with clayey matter, alternate with layers of mud till we reach the surface clay. Data for reckoning the lapse of time in which years are "as moments in the eternal silence" fail us, and we are, as Sir Richard observes, unable to conceive the difference between the recorded times "since the actual surface was first trod by a Roman soldier and the unrecorded time since the sandy soil, eight strata and thirty feet lower down, was trod by the man whose osteological characters are given above." It is a question whether the sand is a more recent foundation than the celebrated gravel-beds of the Somme Valley in which M. Boucher de Perthes first discovered unpolished stone implements, and revolutionized all past ideas of man's place in geological time. Be it contemporary or later, the Tilbury skeleton throws no light on the presence of man in tertiary times, whether of *Homo alalus* (dumb man) in the Miocene age, or of *Homo pithecanthropus* (ape man) in the Eocene age. It is enough that this skeleton adds confirmation to the already superabundant evidence of the remote antiquity of man in western Europe, and of his primitive condition as one inferior to the lowest savages extant.—*Knowledge.*

* "Antiquity of Man, as deduced from the Discovery of a Human Skeleton at Tilbury, North Bank of the Thames." By Sir Richard Owen K.C.B., etc. (London: Van Voorst, 1884.)

HENRY FAWCETT.

THE unexpected death, at Cambridge, on Nov. 6, 1884, of the Right Hon. Henry Fawcett, M.P., Postmaster-General of England, has caused a general feeling of sincere regret. He was not only an able and useful member of the present Ministry, and a thoughtful leader of political opinion, distinguished in the House of Commons by the independence and integrity of his judgment, a university professor of economic science, and an earnest advocate of liberal principles; he was even more remarkable as a man who had both endured and overcome, with undaunted fortitude and perseverance, one of the severest personal afflictions—the total deprivation of sight. His example of courageous self-help in this respect has long won the respect and admiration, as well as the sympathy, of multitudes of his fellow-countrymen, while his public career has been such as never to provoke among party opponents the slightest degree of personal animosity, and his consistency and fidelity to his convictions have never been doubted by those who differed with him in some matters of opinion.



THE LATE RIGHT HON. HENRY FAWCETT, M.P., THE BLIND POSTMASTER-GENERAL OF GREAT BRITAIN.

This distinguished and estimable man was born at Salisbury in 1833, son of Mr. William Fawcett, an alderman and magistrate of that city, who is still living, now above ninety years of age. The mother of the late Mr. Henry Fawcett, also surviving him, is a daughter of the late Mr. W. Cooper, of Salisbury. Mr. Henry Fawcett was educated at King's College School, London, and at Trinity Hall, Cambridge, of which he was elected a scholar; he graduated as B.A., winning mathematical honors as Seventh Wrangler in 1856, and was then elected to a fellowship in his college. He took his degree of M.A. in 1859. It was in September, 1858, when out partridge-shooting with his father, that he met with the extraordinary accident which inflicted on him total blindness. A gun went off, and the shot pierced both his eyes, at once destroying his sight for the remainder of his life. He used afterward to wear spectacles in public and in society, but merely to hide the appearance of his injured eyes, for he could not discern light from darkness. Nevertheless, he resolved not only to continue his studies, and to engage in public business, but also to practice, as far as was possible, every kind of open-air exercise and healthy sport to which he had previously been accustomed. He was fond of athletic pastimes, of walking, riding, skating, rowing, and angling, each of which he contrived to pursue with as much vigor and enjoyment as before. At the same time, he devoted himself to the science of political economy, and to politics in general, having books and papers read to him, and dictating to an amanuen-

sis the essays which he composed for various magazines and reviews. These soon gained him a considerable reputation, and in 1863 he was elected Professor of Political Economy in the University of Cambridge. His standard work, "A Manual of Political Economy," was published a year or two afterward, and was followed, in 1865, by his lectures on "the Economic Position of the British Laborer." In July of the same year he was elected M.P. for Brighton, having previously been an unsuccessful candidate for Southwark in 1857, for the borough of Cambridge in 1863, and for Brighton in February, 1864. He was re-elected for Brighton in 1868. At every contested election he refused, on principle, to pay any expenses beyond those of the official and strictly necessary arrangements; indeed, it has been stated that his private income, scarcely exceeding £500 a year, would not have borne the cost which many other candidates have been willing to incur. In 1857 he married a very clever and accomplished lady, Miss Millicent Garrett, daughter of Mr. Newson Garrett, of Aldborough, and sister of Mrs. Garrett Anderson, the first English lady physician. Mrs. Henry Fawcett, who was born in 1847, has shared her husband's studies and pursuits, and published in 1869 a "Political Economy for Beginners;" she also contributed to a joint volume of essays and lectures, upon various political and economic questions, which they published in 1872, and in 1874 wrote a series of tales, illustrative of political economy. She has taken a leading part, as she is eminently entitled to do, among those who advocate the claims of women to exercise the right of voting when possessed of the same electoral qualification that is required of men. Professor Fawcett taught, wrote, lectured, and spoke with recognized authority upon such topics as pauperism and the poor laws, free trade, industrial and commercial interests, finance, and national education; besides which he bestowed special attention upon the condition of India, and his efforts for the benefit of our Asiatic fellow-subjects, by removing oppressive taxation, were gratefully acknowledged by many of them in communications which have been often noticed. It is well known that his management of the Post Office, during four years and a half, has been characterized by great diligence and administrative skill, and by the introduction of valuable reforms and new institutions, particularly in the money-order system, the savings bank, annuities, and life assurance provisions, the telegraph service, reply post-cards, and latterly the parcels post. In 1883, he was elected Lord Rector of the University of Glasgow. He had the honorary degrees of D.C.L. and LL.D. conferred on him by more than one university. He has left one child, a daughter, about fifteen years of age. His residence in London was at The Lawn, South Lambeth, and in Cambridge at 18 Brookside, where he died. His health seems to have been weakened by a severe attack of diphtheria two years ago, but there was no abatement of his personal activity. The last time he spoke in public was at a political meeting in the Tower Hamlets on the 18th ult. He went from London to Cambridge on Saturday, the 1st inst., and afterward rode on horseback, and entertained same friends to dinner. On the next day he was ill, and was found to be suffering from pleurisy and inflammation of the right lung.—*Illustrated London News.*

MRS. FAWCETT.

1. Rowing. 2. Skating. 3. Riding. 4. Fishing. 5. In the House of Commons. 6. At the Post Office. 7. At a City Luncheon Bar.

SKETCHES IN THE LIFE OF MR. FAWCETT.

NITRO-GLYCERINE IN THE OIL REGIONS.

No history of the petroleum developments would be complete without a reference to the important part that nitroglycerine has played in increasing the production of the region. When this powerful agent was first introduced, only small shots were exploded in the wells. Now it is not uncommon to shoot off 150 or even 200 quarts in a well. Sometimes a startling effect is produced by the introduction of nitro glycerine. At least, that has been the past experience of the oil trade. Only a few days ago it was reported, and generally believed, that the Armstrong well No. 2 in Butler county, Pa., was dry. The ever-vigilant scouts who had closely watched the venture became assured that it was a duster. They telegraphed the news to their employers. On the strength of these reports the market boomed upward, and dollar oil was predicted. About this time it occurred to the owners that it would be a wise policy to treat the well to a dose of glycerine. The scouts laughed, and said the owners were wasting their money The day and hour came, however, and the well was shot. There was a deep and heavy rumbling, as of thunder, then a rushing sound which shook the leaves on the gnarled oaks, and a few seconds later a great stream of oil as thick as a man's arm shot out of the bosom of the earth, and with the airiness of a rocket climbed skyward above the crown pulley of the derrick. Then followed one of the prettiest and most remarkable golden showers ever seen. The field men and the few spectators stood off in the shadow of the woods and watched the exhibition. After considerable difficulty the casing head was adjusted, and the stream of crude oil was directed through nine lead pipes into a big wooden tank. The well produced over 6,000 barrels of oil during the first day, and immediately took rank as the biggest well on earth. Had the owners neglected the use of nitro-glycerine, the trade would never have known the value of this well. Then, too, its conceded failure would have thrown a chill upon the aspirations of ambitious speculators who had paid large sums for adjoining leases. There are other similar cases in the unwritten history of the great oil regions of Pennsylvania.

Another feature of the history in oildom would be a chapter—yes, several of them—devoted to the accidents caused by the careless handling of this terrific compound. In shooting wells the services of a good shooter have to be enlisted. For this peculiar branch of the business not every one is fitted. A professional shooter must possess nerves of iron, be temperate in its habits, and alive at all times to the fact that a careless step may send him flying through the air in a thousand pieces. Nitro-glycerine literally tears its victim into shreds. No accurate record has ever been kept of the number of men who have been killed in the oil regions by nitro-glycerine. The first casualty of this sort which occurred in the oil regions resulted in the death of William Munson, a manufacturer of nitro-glycerine. It was in the summer of 1867, at Reno, Pa. How it happened no one ever knew. Munson went to his laboratory one morning in August, and never left it alive. The explosion was plainly heard in Franklin and Oil City.

In the month of July, 1868, the then bustling city of Titusville was shaken as if by an earthquake. Windows in parts of the town were shattered, buildings rattled, and everybody was badly frightened. It was found that the nitro-glycerine magazine of Colonel E. A. L. Roberts, located some distance beyond the city limits, had blown up. Where the magazine once stood was a hole fully fifteen feet in depth. Patrick Brophy was a tinner in the employ of Col. Roberts. It was his work to make the long tin shells in which the glycerine is placed when a well is to be shot He was of an investigating turn of mind, and visited the magazine frequently to make experiments. He made one visit too many. His remains did not fill a cigar box. Six weeks later Col. Davidson and two of his employes, while at work manufacturing the stuff, were blown to pieces.

In 1869 Dr. Fowler paid a visit to his magazine at Franklin. The magazine blew up, and small pieces of the Doctor were found in the trees. The cause of the explosion is unknown.

One of the most remarkable explosions in the history of the oil region occurred at Scrubgrass near Kennerdell, on the line of the Allegheny Valley Railroad. Mr. George Fetterman one day found a can of nitro-glycerine hidden in the bushes by the roadside. When poured out of the can the stuff resembled lard oil. Mr. Fetterman owned several wells in the vicinity. Unconscious of its deadly contents, he took the can to his engine house, and for two weeks oiled his engine with nitro-glycerine. While pulling out a well, one of the engines journals became heated. Fetterman picked up his oil can and oiled the heated part. The compound then exploded. Fetterman was dragged out of the ruins of the engine house still breathing, but he died in a few minutes.

The first victim who was blown to pieces while transporting the stuff to a well was Charles Clark. Loaded on his buckboard was his rack and four cans of nitro-glycerine. While driving over a rough road near Enterprise the glycerine exploded. Clark was annihilated, the buckboard was reduced to kindling wood, and the horse was blown into fragments. This was in August, 1871.

The year 1872 was marked by the death of five men. While driving from Bully Hill to Franklin, William Thompson was blown to pieces by the explosion of twenty quarts of nitro-glycerine which he was carrying under his buggy seat. A few days afterward the people of Rouseville were shocked by an explosion which killed William Pine. He, too, was driving with a load of the stuff.

One of the first persons on the scene was James Barnum, who a few weeks later shared a similar fate. In October, Charles Palmer was blown to pieces at the magazine of Col. Roberts in Titusville. In company with Capt. West, one of Roberts' agents, Palmer was removing nitro-glycerine from the magazine to a wagon. Palmer handled the stuff as if it were sacks of bran. Mr. West rebuked the man, and cautioned him to be careful. Palmer made thirteen trips between the magazine and the wagon. He entered the magazine for the fourteenth trip, and a moment later the magazine disappeared in a whiff of dust and smoke. Capt. West was not injured by the explosion, but his horses broke into a furious gallop and ran madly through the streets of Titusville, with the cans in the wagon bouncing around at a lively rate. Then West concluded to quit the business. "This is my last torpedo, boys," he said to his companions one day in November. And it was. The torpedo was lowered, but it failed to explode when the weight was dropped on it. West drew it out of the hole. When it reached the top of the derrick floor it exploded, and West was blown to pieces. By the explosion of a magazine at Scrubgrass in May, 1873, Doc. Wright, a shooter, and George Wolfe, a telegraph operator, were killed.

Remarkable was the escape of Andrew Dalrymple's two-year old boy. Andrew was a moonlighter, that is, he manufactured nitro-glycerine and exploded it in wells during the night, as the torpedo patent was owned and controlled by Col. Roberts, who had a monopoly of the business for years, and grew immensely rich out of it. Moonlighters were shadowed by Roberts' spies, and when detected an information was made against the owner or owners of the wells, who were compelled to pay handsomely for their moonlight work Col. Roberts and his heirs brought nearly 2,000 of these suits for infringement of the patent. One night Dalrymple's one story frame house was scattered to all points of the compass. In the ruins were found the bodies of Mr. and Mrs. Dalrymple, both terribly mutilated, but the two-year-old boy was rescued alive and was adopted into a family in Tidioute. It is supposed that Dalrymple was loading a shell when the explosion occurred.

In July, 1874, John Osborne was killed near Parker. The rough roads set off the glycerine in his buckboard. The remains of Osborne, the buckboard, and the horse were scattered through the tree tops.

James Barnum was the agent for Roberts at St Petersburg. On Feb. 23, 1876, he drove to Edinburg and returned with 300 pounds of nitro-glycerine. Shortly afterward a terrible explosion rattled windows and broke crockery in the houses at St. Petersburg. People who rushed to the spot where the magazine was located were greeted with a sickening spectacle. The magazine was gone, trees in the immediate vicinity were stripped of bark and limbs, fragments of human flesh and horse flesh dangled from the stripped branches of the trees, and the ground for some distance in every direction was torn up. One of the dead man's ears was found half a mile away.

W. H. Harper, the inventor of Harper's torpedo, was killed by one of his own torpedoes. In July, 1876, he drew an unexploded shell from a well at Keating's furnace. While he was examining the shell, it exploded. Pieces of tin were driven through him. He lived nine days.

In 1877 Col. Roberts established a magazine at Bolivar Run, near Bradford. While experimenting there on Oct. 2, J. T. Smith of Titusville was killed. Col. Roberts and his nephew, Owen Roberts, who were close by, were badly shaken up, but their injuries were not fatal.

Four men met their death on the Curtis farm, two miles south of Bradford, on Sept. 15 of the same year. A large nitro-glycerine safe was located on this farm. N. V. Pulser, J. B. Burkholder, Andy P. Higgins, and Charles S. Page, the two last named being well-known moonlighters, had made several attempts to rob the safe by stuffing the keyhole with nitro-glycerine and firing it with a long fuse and a slow match. One night, while the men were fussing with the lock, an explosion occurred which killed all.

On Oct. 29, 1878, W. O. Gotham, Harry French, and John Fowler were killed at Petrolia. They had gone to Gotham's factory to manufacture nitro-glycerine. An explosion followed their visit. Gotham's body was found in a stream close by. It was not mutilated. Close by was found the body of French, badly mutilated. Fowler was torn to shreds.

James Feeney is one of the very few men who have passed through an explosion of nitro-glycerine and lived to tell the story. On Feb. 29, 1880, Feeney, in company with Howard Tackett, was riding over six cans of glycerine. The stuff was under the seat in their sleigh. The sleigh was upset in a rut, and the glycerine exploded. Tackett was hurled seventy feet through the air, terribly mangled, and killed. Feeney was buried under a mess of snow and fence rails. His face was burned and his hearing destroyed, but he is still alive. So great was the shock that a dwelling house near by was wrecked, and the inmates injured.

On Dec. 19, 1880, Albert Magee was thawing out some nitro-glycerine on the Ward farm, midway between Bradford and Tarport. The explosive went off, and Magee was killed. Two men close by had their hearing destroyed.

F. A. McClain, a Roberts torpedo shooter, on Feb. 14, 1881, was driving between Davis Switch and Kinzua Junction, and had 200 quarts of glycerine under the seat of his sleigh. The horses became frightened and ran away, and the concussion exploded the glycerine. Man, horses, and sleigh were clean destroyed.

The terrible disaster of Sept. 7, 1881, cast Bradford into gloom. On that day five persons were killed and several others terribly injured. Charles Rust, a Roberts shooter, was engaged to torpedo the Schoonover well at Sawyer City. A large crowd witnessed the exhibition. In the derrick were Charles Rust, Charles Crouse, a moonlighter, James Thrashier, a tool dresser, and William Bunton, the owner of adjacent wells. Rust had filled a shell, and tried to put a cap on it, but without success. He struck the shell twice with his hand. His mangled corpse was found 500 feet from the derrick. The other three men in the derrick were killed. Fred. Slattery, a school boy, passing by, was struck by flying fragments, causing injuries from which he died. Three other boys were severely hurt.

It is supposed that two men were torn into minute fragments by the explosion of a Roberts magazine on the Hatfield farm, near Bradford, on the night of Oct. 18, 1881. Only specks of blood here and there on stones and leaves were ever found.

Strangest of all was the explosion by spontaneous combustion of 1,230 quarts of nitro-glycerine at the Roberts magazine at Kinzua Junction on Dec. 5, 1881. Two of the employes who visited the magazine early in the morning noticed sulphurous smoke issuing from the top cans. They beat a hasty retreat, but subsequently returned and removed eighty quarts of the stuff. Then they retired to a safe distance and awaited developments. An hour thereafter the magazine was swept from the earth. The shock was felt miles away. Forest trees were cut down as if they had been reeds.

One of the most remarkable escapes from death was that of John McCleery, a Roberts shooter. On Dec. 27, 1881, he essayed to shoot the McKinney well, near Haymaker. While he was filling a shell, the well began to flow. He started to leave the derrick, fearing the consequences. The shell exploded, wrecking the derrick and knocking McCleery down. As he was on the point of rising, four other cans in the derrick exploded, and he was hurled violently through the air. Stunned and bleeding, he picked himself up and started off on a run, and only fell down when exhausted. His back was filled with pieces of tin and splinters of wood, but the injuries were not serious.

Harvey W. McHenry, a shooter who had had many thrilling escapes from death, was killed on Feb. 5, 1883, at Simpson Station. He was literally blown into atoms.

Lark Easton went to Coleville last summer to shoot a well for Spence & Dennis. He left four quarts of nitro-glycerine in the wagon; the balance he took to the well. A storm came up, and a tree was blown down. It fell across the wagon. The glycerine exploded, demolishing the wagon and killing one of the horses.

It is estimated that at least twenty or more persons have lost their lives while fooling with empty nitro-glycerine cans.

"During the past two years," said Mr. Perkins, the bookkeeper for the Roberts Torpedo Company in this city, "the Roberts Company has had only one man killed by glycerine. Glycerine is now so cheap that it is almost universally used to increase the production of wells. The company has kept a record of all the explosions that have occurred during the past eighteen years. In every instance death was caused by carelessness. Nitro-glycerine, when solidly frozen or in liquid form, is easily and safely transported. The favorite method is to carry it thawed out. All the magazines of the company are kept warm and heated to a high temperature. Glycerine, you know, freezes at 42 degrees. The glycerine, when ready for transportation, is put into long tin cans and placed in a padded wagon. Between each can is a padding of horsehair, while above them are placed tiers of corks. The wagon is then locked. There are numerous instances where the shooter's wagon has been capsized without injury to any one. We have almost daily applications for work. The men do not receive much better wages than other branches of skilled labor, but they seem to have a fascination for the work."—*N. Y. Sun.*

STEAM YACHTS.

At a recent meeting of the Engineers' Club, of Philadelphia, Mr. John Haug presented a description, illustrated by drawings and test specimens, of Mr. William Astor's new steam yacht, the first sea-going steamship built of steel in this country. She is 235 feet long on load water line, 30 feet beam, and 20 feet deep, and has two complete decks of ¼ inch steel plates. Her machinery consists of a compound engine, with cylinders 34 inches and 60 inches diameter, and 36 inches stroke, supplied with steam of 85 pounds pressure by four oval boilers built of steel, and having 170 square feet grate surface and 4,200 square feet heating surface. Her hull and machinery have been arranged according to Lloyd's rules for a class of 100 A1, and she has been specially surveyed while building. Lloyd's rules for steel vessels require a material having a tensile strength of not less than 27 nor more than 31 tons per square inch, having an extension of not less than 16 per cent. in a uniform length of 8 inches. Steel of greater tensile strength has been found proportionately deficient in ductility. The plating for the above vessel, supplied by the Danville Iron and Steel Company, of Danville, Pa., was found to be of very good quality, the tensile strength varying from 62,000 pounds to 72,000 pounds per square inch, the extension (in 8 inches length) from 20 to 24 per cent., as shown by several samples. Some samples showed as high as 90,000 pounds tensile strength, but the extension was only 6 to 10 per cent., rendering it unfit for use. The steel for the boilers was also of superior quality; one test piece, cut diagonally from a plate, showed no difference from others cut lengthwise. A test piece with punched hole broke at 57,000 pounds, while one with a drilled hole broke at 61,000 pounds, showing less difference than is generally supposed. Some pieces, bent double, after having been heated and quenched in water, showed a remarkable softness and ductility. The material for the frames and beams of this vessel was supplied by the Pencoyd Iron Works, and fulfilled the requirements of the rules, as shown by numerous test pieces.

Mr. Fairman Rogers described the steam yacht Magnolia, built in 1882, by the Herreshoff Manufacturing Company, Bristol, Rhode Island. The following conditions were required to be fulfilled in her design:

Light draught, not more than 4 feet; length and breadth such as to enable her to pass through the Erie Canal locks, which are 100 feet by 18 feet; flat floor, large accommodations for cruising and for a long residence of the owner's family on board, flush deck, no projection of steam drums, etc., above deck, except the smoke stack. Low speed, not less than 8 miles per hour. Minimum head room below, 6 feet 6 inches. Adapted specially for inland cruising along the Atlantic coast. She turned out to be entirely satisfactory. Her ordinary speed is 10 miles, maximum 11¼ miles. She has twin screws 36 inches diameter, 50 inches pitch, two compound condensing engines, 6 inches and 10¼ inches by 10 inches—45 pounds steam, 270 turns per minute. Two flat coil square boilers. Entire motive power weighs five tons. Consumption of coal (anthracite), 165 to 200 pounds per hour. Carries 15 tons. She is schooner rigged and sails 6 knots, dragging her screws. Bent oak frames, 3 inches by 3 inches; yellow pine planking, 2⅜ inches; white pine deck, 2 inches; mahogany rail and deck fittings.

A, reefing boom, a split spar, half on each side of sail. B B, pennants for hauling down the boom. C C, reef points for stopping the reef boom. D, tackle for hauling down the pennants. E E, rudders. F, center-board.

CENTER BOARD CATAMARAN.

To the Editor of the Scientific American:

In your SUPPLEMENT, No. 463, of the 15th Nov., I see a description, with illustrations, of a center board catamaran by an old Jack Tar away off in Russia.

He speaks of having improved his original design by adding a deep keel.

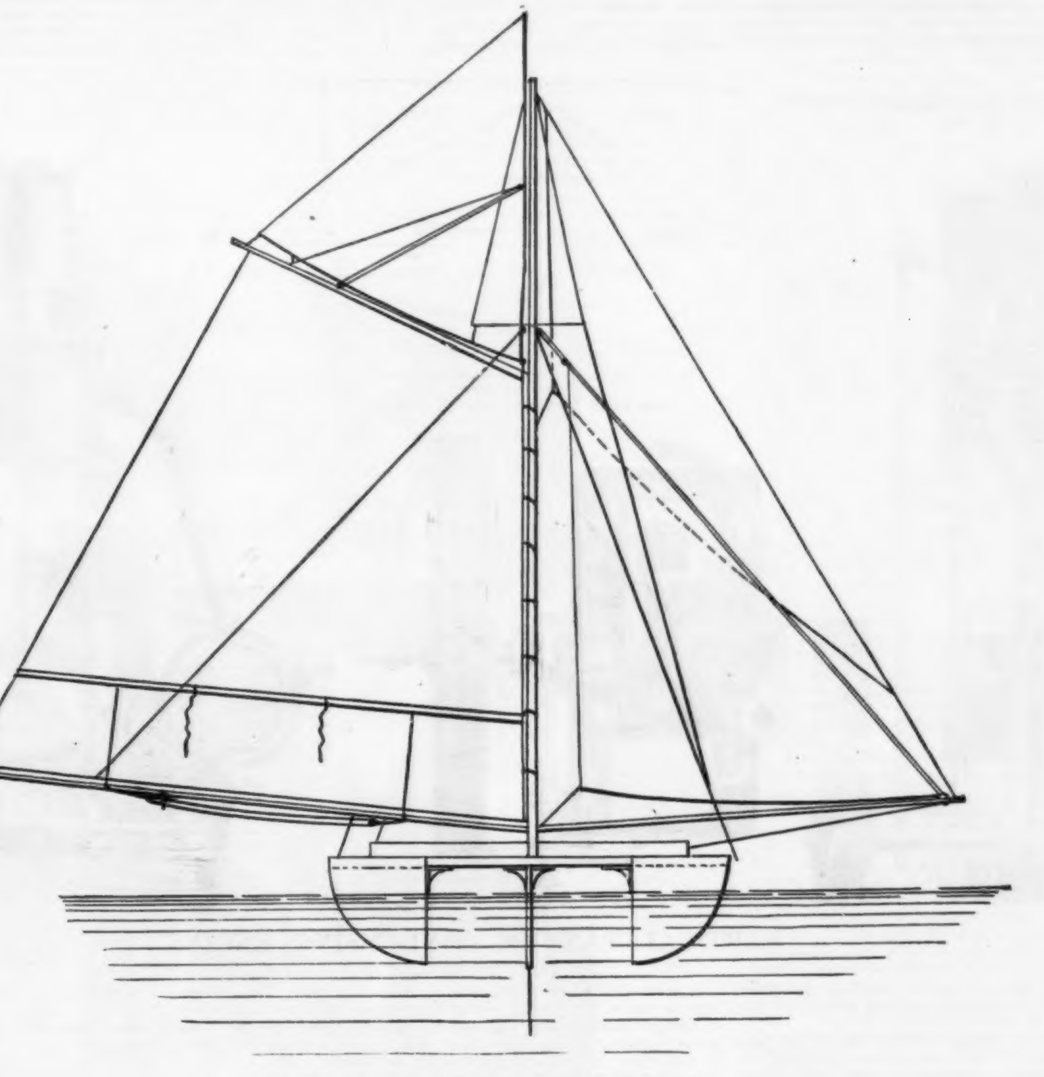
Several years ago I made a model of a catamaran which I shall describe. The buoyant parts of the craft consist of two half-boats; that is to say, a good modeled life-boat split in two at the center line, each being 24½ inches long, over all; 4¾ wide amid ships; and 3⅛ deep. These two floats, flat on the inside, are fastened 9½ inches apart. A back-

bone or center keel of metal, 18½ inches long is securely kneed off to the beams which secure the floats asunder; and there is a center board working in the center of this back-bone which is also of metal; the bottom line of the back-bone is flush with the base of the floats, which have no projecting keels. It will be seen that the thin back-bone, which is very rigid and answers for ballast, with the center board dropping 3 or 4 inches below it, gives great hold-on power, and the straight side of the weather float adds much to the important function when sailing on a wind. The rig of my craft is somewhat similar to that in the SUPPLEMENT. The dimensions are: Mast from deck to truck, 30½ inches; boom, 23; gaff, 13; hoist of main sail, 20 inches; bowsprit outboard, 10 inches My main sail has a reefing boom, *whereby the sail can be snugly reefed while in stays.* My jib is fitted on an entirely new plan. The mast is stepped on the back-bone, or rather clasps it by an opening in the heel, and is supported by widely spread shrouds and a stay going to the end of the bowsprit as usual. Attached to the forward side of the mast near the deck by means of a goose neck is a spar, which I call the *jib-boom;* it is just long enough to clear the stay; to the extreme forward end is attached a stout rope, which I call a jumper, passing through a leader on the bow-sprit and setting up in board *within reach of the cock-pit.* On this spar is a traveler like those used on the bowsprits of cutters; when the jib is to be set, the tack is hooked to the traveler, and hauled out to the end; then the sail, which, like a cutter's jib, must have a stout luff rope, is hoisted, and the sheets trimmed as usual. I have also a gaff top-sail, and a jib top-sail.

The jib-boom has guys leading to a point near the shrouds, and when going free, the jumper being slacked and the guys properly tended, the jib-boom is hauled in so as to be *nearly on a line with the main boom,* thus forming what may be called a studding sail. The sketches herewith will show the rig clearly. I should have said that in the forward end of the back-bone is a rudder which shuts in flush, as in some ferry-boats, and in the after end is the rudder proper, which is operated by a tiller. The forward rudder is about half the size of the after one, and is operated by a yoke with ropes leading aft, and *is intended to be used only in tacking, or when it is desired to give her a quick sheer.* Assuming that my floats are sufficient to carry the back-bone, the mast and sails, the passengers and stores, I expect that a boat 49 feet long (my model being on a scale of ⅛ inch to the foot) would be very stiff and fast and hold an excellent wind, and going free also be very fast. My deck accommodations consist of a rising or bulwark extending from abaft the rudder head nearly to the mast, and from side to side, 18½ inches by 5½; as the outer ends of this cock-pit lap over the floats, there is room for a companion way to each, for the purpose of going into cabins, which in a boat 49 feet long would give about 9 feet in the clear, in breadth, if the boat be made of steel, as she should be.

One illustration, half size of my model, shows the rig when on the wind, and the smaller one, half size of this, shows her going before the wind. The dotted lines in the largest drawing show the rudders and the center board. As to the quantity of sail to be carried safely, we must depend mainly on experiments.

R. B. FORBES.



CENTER BOARD CATAMARAN.

THE WORKING OF GAS ENGINES.

THE search for a hot cylinder gas engine has been taken up by many experimenters, whose qualifications for the task to which they addressed themselves have been very diverse. Some have brought to the problem the highest preliminary training in mathematics and physical science; while others have dared the attempt with the light heartedness of the born inventor, who regards all previous acquaintance with his subject as a positive disqualification. The demand has not in this instance created the supply; and, notwithstanding all that has been done in the matter, the desired object seems at this day as far off as ever. All that is known is the initial fact that a hot cylinder gas engine would realize a very notable economy in comparison with the engines whose cylinders have to be cooled by currents of air and water. This has been made evident by the labors of a number of experimentalists who have addressed themselves to the examination of the best type of existing gas engines, which, tested upon the basis of the intrinsic power of the fuel with which they are fed, are shown to be wasteful machines. Nor does there seem to be any reason why, in the nature of things, this should always be so. Every philosopher who has, during the past twenty years, looked at the question from a high standpoint, down to Lord Rayleigh in Montreal last month, has conceded the possibility of great improvement being made in the gas engine. This opinion is fully participated in by the numerous inventors whose designs fill our Patent Record week after week. It is a remarkable illustration of the possibility of the whole industrial world looking in one way, and yet missing the object sought for.

Among others, M. Witz, a French professor of physical science, has contributed something to the stock of knowledge on the subject—not exactly of a hot cylinder engine, but of the need for it. In a recent paper published in the *Journal de l'Eclairage au Gaz,* Dr. Witz enlarges upon this subject in a highly instructive manner. In giving our English readers an abstract of this learned communication we must begin by regretting the poverty of our language in respect of two words, often used by French engineers, for which no equivalent in English is known to us. The first is *paroi;* the second, *foyer.* The two languages have lent and borrowed of each other convenient expressions so freely that we are almost tempted to follow the precedent in the present emergency. The title given by Dr. Witz to his paper is "*De l'action de paroi dans les motours à gaz tonnant;*" *paroi* in this case meaning the sides, periphery, substance, etc., of the cylinder. It implies, in short, the whole material and structure of any vessel in relation to its content; and is a most expressive word, particularly when used in connection with a gas engine cylinder. The other word need not be explained here; but any one who knows how frequently it is used to express something that requires a whole sentence in English will appreciate our regret at being debarred from its use.

Dr. Witz begins his memoir with the declaration that the *paroi* of a cylinder plays an important part in heat engines. Its action in the steam engine is well known; the steam which comes from the boiler encounters a wall of cast iron, perfectly clean and comparatively cold, upon which it immediately condenses. The metal accordingly becomes covered with a film of liquid more or less thick, which vaporizes afresh during the periods of expansion and exhaustion. Thus there is partial condensation during admission of steam to the cylinder, followed by evaporation during the other working periods; the consequence being a loss which can only be ameliorated by the use of a jacket of live steam. This jacket reduces condensation during the first period, and supplies to the walls the heat carried off during the second period. The result of this double action is to increase the work during the period of expansion, and to annul the loss in the condenser by reducing to the minimum the quantity of water inclosed in the cylinder at the end of the stroke.

Steam jackets, which had dropped out of vogue, have reconquered the position given them by Watt, which they should never have lost. The best modern constructors are now careful to steam-jacket not only the sides of steam cylinders but also the ends, and even the pistons. From his own experience, Dr. Witz values the saving thus realized at 15 per cent.

That the action of the *paroi* is not less noteworthy in gas engines might be affirmed *a priori.* Dr. Witz takes it upon himself to demonstrate that it is much more important. All gas engines exceeding one or two horse power are surrounded with a cold water jacket. The heat removed by this is enormous. In an excellent "Otto" gas engine experimented with by the author at the Roubaix Gas Works, it was found that the heat lost in this way was 40 per cent. of the disposable energy, and 48 per cent. of the utilizable heat. M. Tresca found a loss from this cause of 52 per cent. with a Lenoir motor. All the waste resulting from the imperfect expansion, the discharge of hot gases, and the passive resistance of the machine disappeared in this colossal waste. In the "Otto" engine referred to, which was well constructed, well looked after, and worked perfectly, the normal consumption of gas was not usually more than 1,000 liters per hour. To move it without any load, the consumption was 400 liters per hour per nominal horse power, or nearly half its requirement for full work. All this heat went into the water tank or into the air with the exhaust.

This is the grave and ruinous imperfection that designers have so long sought to correct. Indirect solutions of the problem have been attempted, such as M. Hugon's device of pulverizing water in the explosion cylinder, to gather the lost heat and facilitate lubrication. Such is also the plan of Messrs. Simon & Son, of Nottingham, who place the gas cylinder in the midst of a steam boiler, and use the boiler pressure to help the gas. The result of these attempts has, however, been only mediocre. It would seem to be necessary in the first place to know perfectly the working of these motors; to analyze the phenomena which take place behind the piston, before seeking to improve the performance. In a word, it has appeared advisable that the physicist should precede the engineer. Dr. Witz has endeavored to personate the former character, with the aid of appliances placed at his disposal in the laboratory of the Lille Faculty of Sciences.

It was determined to produce, as it were, artificially, the phenomena of explosion and expansion which succeed each

other behind the piston of the gas engine, varying these in their principal circumstances. For this purpose the author made use of a cast iron cylinder, placed vertically, 200 millimeters internal diameter, and 400 millimeters high. A piston weighing 14·5 kilos, provided with bronze rings, moves upward through a travel of 323 millimeters under the pressure of an explosion behind it; the weight of the piston and the friction of the rings being together equal to about 31·5 kilos, which is the weight of a counterpoise enabling the piston to move easily up or down. The counterpoise actually used, however, weighed 75 kilos; and it was connected to the piston rod by a line provided with a brake. By this arrangement the velocity of the piston, and, consequently, the rapidity of expansion, was at the disposal of the operator. The piston rod was graduated to form a gauge of the bulk of gas behind it; and the inflammable mixture was admitted by a cock and fired by an induction spark. After an explosion had taken place, the piston rose until the resistance of the air and the constant resistance of its weight and friction balanced the ascensional force. It descended slowly, in proportion to the refrigeration and condensation of the products of combustion. The pressures developed under the piston were indicated by diagrams taken with a Richard indicator; and the time was recorded on the same card by a tuning fork vibrating 128 times per second. Thus the card showed at once the volumes and pressures of the gases, the velocity of ascension of the piston, the duration of the phenomenon of expansion, etc. The memoir then proceeds to give in detail the method of calculating results from the data thus obtained. Dr. Witz recognizes that the phenomena arising from the combustion of explosive bodies have been studied by many investigators. He points out that these experiments were all made in closed receptacles, without expansion; while, by his arrangement, expansion is elevated into a considerable factor, and the results are presented in a new light. The employment of high expansion presents in particular the double and precious advantage of limiting temperature and reducing the pressure developed 9·4 volumes of air, the temperature of explosion does not exceed 1,600° C. in a constant volume.

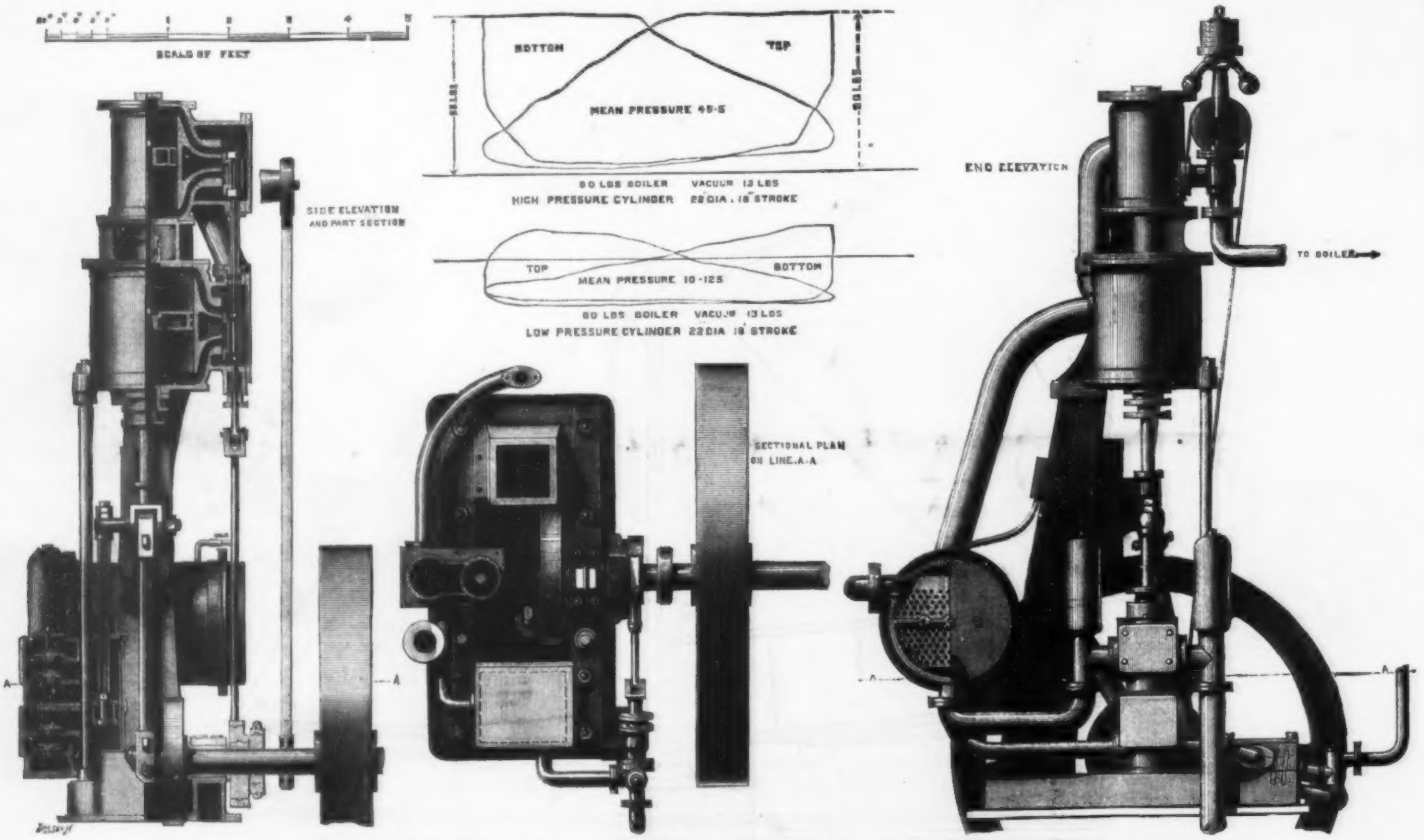
The first object of the author's experiments was to observe the effect produced upon an explosion by the velocity of expansion. Briefly, without reproducing the details given in the memoir, it appears that for carbonic oxide, as for coal gas, the useful work increases with the velocity of expansion. A complete analysis of the phenomenon, permitting the author to follow the rapidity of combustion, has shown him that, as the velocity of expansion increases, combustion is by the same fact rendered more rapid. In short, Dr. Witz has been led to formulate these two theorems: (1) Utilization increases with the velocity of expansion, and (2) combustion is so much the more rapid as the velocity of expansion is more complete. These laws are of fundamental importance in connection with gas motors. In fact, this great influence of the velocity of expansion is but a consequence of the action of the *paroi*. How can the modification of all the phenomena of explosion by the velocity of expansion be otherwise explained? It can only be by the cooling of the metallic surface, which, exercised during a shorter or longer time, subtracts heat proportionately from the explosion center and diminishes the intensity of the reaction. It is not only the rapidity of combustion which is subject to this influence, but the surface of the diagram itself is reduced; the work diminishes, and the utilization falls, as already stated. To extract the best possible portion of the heat disposable from explosive mixtures it is necessary, therefore, to arrange the expansion of the products of combustion in the shortest possible time, and to reduce the surface of the cylinder to the minimum; that is to say, to reduce $\frac{\text{surface}}{\text{volume}}$ to the minimum. There will be also recognized the great advantage of realizing the maximum $Q \cdot V$ (the proportion of the quantity of disposable heat to the volume occupied by the explosive mixture). In other words, the real practical as well as theoretical advantage of compressing the air and gas before ignition will appear.

tain an engine of the same power, and not suffer himself to be seduced into purchasing a larger one. To work the "Otto" engine to its full capacity, with hot water, is therefore the sum of Dr. Witz's practical advice to power users. As to engineers, he declares that the hope for the future of the gas engine rests in modifying the cooling influence of the cylinder.—*Journal of Gas Lighting.*

VERTICAL TANDEM ENGINE.

As a specimen of English practice we illustrate a vertical tandem compound surface condensing engine, by Worth, Mackenzie & Co., of Stockton-on-Tees.

The compound engine has one high-pressure cylinder 12½ in. diameter, the lower flange of which is bolted to a distance piece 9 in. deep carried on the top flange of the low-pressure cylinder, which is 20 in. diameter. The high pressure piston has two external rings of hard bell metal, and one internal ring of steel, and is secured to the rod by a nut with a steel pin through the nut; to prevent this nut from working loose there is an octagonal recess ¾ in. deep cast in the top side of piston; this recess is about 1 in. across larger than the hexagon nut, and is slightly dovetailed and run up with patent metal after the nut has been well tightened up, making a thoroughly secure job. The stroke of both pistons is 18 in.; the piston rod is of forged steel, 3 in. diameter for the lower cylinder, and 2¾ in. diameter for the 12½ in. cylinder, and passes through gun-metal bushes in the distance piece, and is made tight by one gland. By this arrangement the piston rod between the cylinders is never exposed to the air, room is saved, and the gland is found to keep tight with very little attention. The crosshead is of cast steel, and is secured to the piston rod by gib and cottar, so arranged that by reversing the position of the same the rod can be forced out of the crosshead when required. The crosshead shoe bears on a motion bar of hard cast iron, which is secured to the planed face of the column by turned bolts. The cylin-



VERTICAL TANDEM CONDENSING ENGINE.

by the explosion. By limiting the temperature, the effects of dissociation, which do not appear under 1,500° C., are also avoided.

Taking the volume and surface of the tube of the inlet cock comprised between the cylinder and the plug, the volumes and surfaces corresponding to the first four gauge-marks of admission are—

	Volume.	Surface.	Surface Volume.
First notch...	1066 cubic c.	906 square c.	0·85
Second " ...	2081 "	1109 "	0·53
Third " ...	3096 "	1312 "	0·42
Fourth " ...	4111 "	1514 "	0·35

When commencing the experiments it was found that illuminating gas offered most serious difficulties, because of the variations of composition from one day to another in the gas supply or the same town. Certain experiments conducted in February could not be connected with those of June, although made under identical conditions. A mixture which, in winter, showed incomplete combustion with admission at the third notch, burned completely in summer. The author is content for the present to note this fact, which he is now studying more fully, and will treat of on a future date. These variations in the heating power of coal gas necessitated special researches with an explosive mixture of constant composition. Eventually a mixture of carbonic oxide and air was selected; the former being produced by the action of sulphuric acid upon yellow prussiate of potash, the accompanying cyanhydric acid being retained by a washer, and the washed gas stored over water. Dr. Witz gives the heat developed by the explosion of a volume of this gas with varying proportions of air. The common coal gas of the Continental Union Gas Company, of Lille, has a calorific power of 5,530 calories per cubic meter. The complete combustion of this gas requires 5¼ times its volume of air, developing by the explosion of this mixture a temperature of 2,200° C. and a pressure of 9 atmospheres. By mixing the gas with

A great deal of the superiority of motors of the "Otto" type is due to the extreme rapidity of expansion of the gas in their cylinders. The action of the *paroi* is, therefore, the great regulator of explosive phenomenon. It is competent to accelerate or slacken combustion, to produce slow and gradual combustion; it performs some functions in this respect sometimes ascribed to dissociation. Dissociation is not necessary to explain them, however, for they can be reproduced in cylinders wherein the temperature does not surpass 1,400° C. Dilution renders this slow combustion more apparent; but the phenomenon of prolonged combustion can be produced independently of dilution. This perfectly logical deduction invalidates and confirms by turns the theory sustained by Mr. Dugald Clerk. With Mr. Clerk, Dr. Witz holds M. Otto to be in error in trying to retard combustion, which is an imperfection. Unfortunately, this retardation (*Nachbrennen*) cannot be avoided altogether. Why? According to Mr. Clerk, because of the progressive development of dissociation, together with combustion in the explosion chamber; according to Dr. Witz, because of the action of the *paroi*, which can be only reduced, not totally suppressed. Dr. Witz agrees with Clerk's affirmation that Otto's success is due to compression alone, and not to the extreme dilution of the explosive mixture by the products of the combustion of a previous charge.

In order to prove yet again the importance of the action of *paroi*, Dr. Witz experimented with the cylinder maintained at various temperatures. The result in all cases showed the preponderating influence of refrigeration, which deforms the cycle and lowers the duty of gas engines. As to the possibility of improving this class of motors, Dr. Witz is sanguine. Still he holds that the "Otto" type of engines is better than anything that has yet appeared. The "Otto" engine will work more economically, and with perfect safety, the author declares, if the circulating water be warmed to 75° C. In the next place, he strongly advises that all gas engines should be worked to their utmost capacity. Any one requiring a force of so many horse power should ob-

ders are carried on two wrought iron pillars at the front and on one cast iron column at the back. The condenser is usually cast in one with this column, but in this engine, as there was a possibility of damage through frost when the mill is idle at Christmas holidays, it has been considered better to make the condenser independent and of wrought iron. The condenser is 2 ft. diameter by 2 ft. 6 in. long, and contains 162 tubes of brass; the total surface is 84 square feet, and the vacuum varies from 12½ lb. to 13½ lb.

There is one pump 6 in. diameter by 18 in. stroke, the bottom end of which is the air pump and the top end the circulating pump; it is lined with gun-metal, and has gun-metal bucket and rubber valves on brass grids. There is an air valve fitted on the cover between the valves of the circulating pump, by means of which the quantity of circulating water can be regulated, and which has the further effect, in combination with large air vessels, of keeping the pump noiseless. The air pump delivers to a hot well situate at the front of the engine, from which the feed pump, 2½ in. diameter by 3 in. stroke, drains its supply. The pump is driven by an eccentric cast in one with the valve eccentric, and there is an arrangement in the hot well to prevent any grease being pumped into the boiler.

The connecting rod is of wrought iron, and the bearings in the same are of phosphor-bronze, and 2½ in. diameter by 4 in. long for the small end and 3½ in. diameter by 5½ in. long at the crank ends. The disk is of cast iron with a steel pin, and has a wrought iron hoop 4 in. by 1 in. shrunk on. The eccentric sheaves and straps are of cast iron, and the valve eccentric is 4 in. broad; the eccentric rod is of wrought iron, and the double-eye is made unusually large, and provided with a brass block adjustable by wedge and nuts to take up any wear.

The slide valves are of the hardest bell metal, and have 4 in. travel; the lap is $1\frac{1}{16}$ in. at top, $1\frac{1}{16}$ in. at bottom, and lead $\frac{1}{16}$ in. at top and ⅛ in. at bottom. The governors are of the high-speed type, and work directly on the equilibrium valve without the intervention of any levers, and are able to

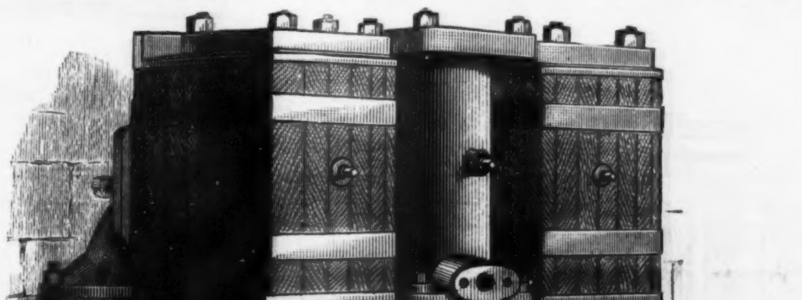
control the engine under the most sudden changes in the load.

This engine is coupled directly to the mill shafting, and is driven at 118 revolutions per minute by the same boiler and at the same pressure, and the results of twelve months' workings are as follows: Value of coal consumed by high pressure engine 18½ in. cylinder, 4 ft. stroke, £99 1s. 8d.; ditto by compound 12½ in. and 20 in. cylinder, 18 in. stroke, £34 7s. 9d.; saving, £64 13s. 11d. Water used by the high-pressure per week, 14,000 gallons; ditto by the compound, under 1,000 gallons; saving 13,500. The water of the river Tees is used for condensing, but is quite unfit for boiler feeding. The 1,000 gallons named of town water is used to make up waste.

This engine was intended to develop 85 horse power, but there has as yet been no opportunity of indicating it with a full load on. We therefore publish diagrams taken from another similar engine, the dimensions of which are as follows: Diameter of high-pressure cylinder, 12½ in.; diameter of low-pressure cylinder, 22 in.; stroke of both, 18 in.; revolutions per minute, 120; air pump diameter, 7 in.; stroke, 18 in.; condenser surface, 116 square feet. The dimensions of the cylinders for these engines were worked out in accordance with the rules given in *The Engineer* of October 17, 1879, and the latter engine was intended to indicate 100 horse power, with 70 lb. initial pressure, and it will be seen from the diagrams that the actual result works out very closely, in accordance with the rule, indicated power being 102·8, with initial pressure of 68 lb. and 69 lb. respectively. This engine replaced a double 12 in. cylinder high-pressure engine, and is driven from the same boiler at 20 lb. higher pressure, but through a considerable length of steam pipe. Steam can be easily maintained to indicate the 100-horse power with the compound engine, but could not be kept up to drive the non-condensing at more than 50, and the consumption of fuel with the latter engine was 50 per cent. more. Says *The Engineer:* Engines of this description, being surface-condensing, can be used wherever a supply of cold water can be had, no matter how dirty or salt that water may be. They are safer and require less attention than a high-pressure engine, as the feed will take care of itself for hours together, and the boilers may be worked three times as long without being cleaned out.

VERTICAL COLD-AIR MACHINE.

The special features of the machines by Messrs. J. & E. Hall, of London, are their compactness and their noiseless working. The machine we illustrate delivers 5,000 cubic feet of air per hour at a temperature of 75° below zero, running at a speed of 150 revolutions per minute. The space occupied by this machine is very small, being only 3 feet 6 inches × 3 feet 3 inches × 5 feet 10 inches. It can be used either in the vertical position, as illustrated, and bolted to a bulkhead if for use on board ship, or it can be fixed horizontally. One of the special features in the machine is the use of slide valves for the compression cylinder, instead of the ordinary beat valves, which permit the machine to run at high speeds without the objectionable noise made by the beat valves hammering on their seats. The steam, compression, and expansion cylinders are bolted to the bed of a strong engine frame, which is secured to the cooler box. Each cylinder is double acting, and the connecting rods from the steam and expansion cylinders act on crank pins in the two disks, the compression connecting rod on the crank in the center. The cranks are placed relatively to each other in such a manner that the greatest effort is being exerted at the time of the greatest resistance; and although the disk plates are small, the machine can be run at slow speeds without perceptible irregularity in the motion. The slide valves for all the cylinders are worked from two weight shafts; the main valve weigh-shaft being actuated by a crank pin at the steam end of the crank shaft, and the expansion valves being driven from the crosshead pin of the compression cylinder. The smaller machine is similar in design to the large one, and delivers 2,000 cubic feet of air per hour at 225 revolutions per minute. The space required for this machine is 2 feet 4 inches by 2 feet 3 inches by 4 feet.—*Iron.*



VERTICAL COLD-AIR MACHINE.

A PERPETUAL MOTION MACHINE OF 1812.

There is in the Franklin Institute, of Philadelphia, a model of the Reidheifer perpetual motion machine of 1812, which was thus referred to in a recent lecture of Prof. Coleman Sellars:

There are glass plates below the steps of the driving and driven wheels, that these plates can be taken out to offer convincing evidence that the wheels were not connected in any manner with any source of power outside the machine itself. One can scarce look at this machine without feeling astonishment that any one should have been deceived by the wily man who claimed so much for it as to warrant an examination by a commission at the instance of the Senate and House of the State of Pennsylvania in General Assembly met. This was in 1812. I have talked with many who were active men at that time, and I know that its believers were numbered by the thousands. One old man told me how, meeting a fellow traveler one night as he jogged out to his home in Montgomery county, they adjourned to a wayside inn, and there his companion made from an old cigar box a model to prove that Reidheifer's perpetual motion would do what was claimed for it. The sun was beginning to show itself when they were done with the interesting argument. Listen to the argument: "A loaded wagon will run down a hill. If the hill is steep enough, and the hill is capable of moving out from under the loaded wagon, then, if the wagon is prevented from moving except in a vertical direction, it will push the hill from under it. Now in this so-called perpetual motion machine there are two hills or inclined planes mounted on opposite sides of a wheel, which wheel is horizontal, its axis being vertical. There are loaded wagons on the two inclined planes, and as the wagons cannot go down the inclined planes, but are held by a complicated system of levers, and the inclined planes cannot move from under them, therefore the effort to do what both are prevented from doing results in a constant push, and the wheel is supposed to be driven around by this power." There are many stories told about this commission's visit to see the machine. One name on the commission is that of my grandfather, and his son, my father, went with him to see it, and noted that while the large wheel was supposed to drive the small one, yet the wear on the teeth was on the side of the teeth that would indicate that the small wheel was driving the big one. It is said, too, that Isaiah Lukins, the maker of this model, was also present, and said the jerky motion of the machine was very indicative of a crank turned by hand-power. The commission found out nothing, for they were not permitted to probe too deep, but they were none the less sure that gravity without motion in its own direction can impart no motion to other parts, no matter what complicated system of devices is made to take part in the fraud.

Another model was made that has since been destroyed by fire, which model could be taken apart and examined in detail; its bearings were on glass and when it was restored, all parts in proper position, it would show no signs of motion until the weights on the little carriages were placed on them, and then the machine would run. I bring this old model to your notice this evening as a reminder of how very easy it is for those who are not well grounded in the fundamental laws of mechanics to be deceived. From the time of the perpetual motion machine of the Marquis of Worcester down past Reidheifer, in a time nearer to us, there have been presented innumerable such follies as this old model shows, and the world is full to-day of those who, if they had the money to spend, would risk it in such foolish ventures. It is even said that in this present day there is not, one hundred miles from where we now are, a greater wonder in the mechanical line [the Keely motor.] I persume it is so, but I have not seen it.

FUSTIAN, BEAVERTEEN, MOLESKIN.

Under the names of fustian, beeverteen, and moleskin, a cotton fabric is imported which is a specialty of the industries of Linden, near Hanover, Mulhouse in Alsace, and M. Gladbach, known in Germany as "Deutschleder," that is, German leather. In its contexture it is very similar to drell (which the Germans call English leather), but it receives by a particular after-treatment a degree of firmness and durability near to indestructibility, like corduroy, to which it is superior in appearance. The various manipulations constituting the finish of the material are a kind of mercerization and fulling, or, as the *Centralblatt für die Textil-Industrie* describes them, boiling, teaseling, dyeing, passing, drying, and shearing. The rough cloth, as it comes from the loom, is sewed together, in lots of 6 pieces of about 40 m. or 50 to 60 lb. each, or attached to one another with copper pins, but never with iron pins, which would cause rust stains. Thus the lot is entered into the dyeing machine (pilot, roller tub), and boiled in clear water until perfectly wetted out. Then a milk is prepared of 12 lb. slaked lime and plenty of water, carefully strained and put into the machine, well stirred and brought to a boil, when the material is entered and boiled for 2 hours. After washing out of the lime bath, the material is acidified by running it four times in a bath of pure water at 122° to 144° F., containing 3 lit. hydrochloric acid; whereupon it is well rinsed, pressed upon the water calender, and dried. By this treatment, which might be called chemical fulling, a shrinkage of the tissue is caused both upon its length and width; it becomes closer and specifically heavier, and much firmer, undergoing a similar alteration as woolen goods in the fulling mill. Cotton tissues thus densified proceed from the dye tub with the same intensity and brilliancy of color as woolens. The dyestuffs penetrate into the fiber, and do not only fix themselves upon the surface of the tissue; they are also absorbed and fixed in a greater proportion, so that they do not deteriorate unless the surface of the cloth is actually destroyed.

The effect of the boiling lime bath is very strikingly illustrated by dyeing in the same bath samples of the same tissue, one of which has been treated with lime and acid, the other not; when the former will prove much more intensive, fiery, and fast in color than the other. Another advantage of this treatment is, that the material can be better teaseled, because the teasels meet with more resistance, and the weft threads are not so easily displaced. It is a fact ascertained by experiment that tissues which have been either steamed previous to teaseling, or boiled in water, or better yet in lime or caustic soda, become finer, evener, and better covered by teaseling and shearing than those which are not thus treated.

The teaseling operation is of main importance in the manufacture of fustians, and requires, besides a skilled dresser, a teaseling machine especially adapted to this kind of goods, such as constructed by Francis Miller, of M Gladbach, with an armature of fine wire teasels. The teaseling must not be finished in two or three passages upon the machine, as for beaver and like goods, but very gradually and evenly. Care must be had that the tissue be well tentered, and that it have a sufficient but not too taut tension lengthwise; which is easy to regulate by proper tenter arrangements and brakes. The fustian is first given a passage upon the wrong side, when the card roller of the teaseling machine is exactly adjusted upon the desired biting point, in order to get the correct position of the cards for the right side, as perfection of shearing is not so material for the wrong as for the right side. A good cover is obtained by eight passages upon the teaseling machine with good teasels of No. 28 wire which are not ground too sharp. The best method is to teasel the left and right side alternately, as the material suffers less by this plan, and with goods of a light quality the weft is not liable to be displaced.

After teaseling, the pieces are again sewed together by sixes, following the direction of the teaseling; for that purpose the far end of each piece is marked with the number of the piece or some design stitched into it. By this means mistakes are prevented in those manipulations where the pieces are to run in the sense of the shearing, the marked end being the shearing end and the grain going from the other end to the shearing end. Thus the goods are again entered in the dyeing machine, and run for one hour in a boiling bath consisting in pure water, to which 4 pounds caustic soda 80 per cent., previously dissolved in boiling water, are added. The goods are then well rinsed, and, after replacing the caustic soda bath by a 133° F. bath of pure water, to which 3 liters hydrochloric acid have been added and well stirred, they are given four passages upon the acid bath. The goods are then well washed in order to remove the acid; and to insure a perfect deacidification, 1 liter spirit of ammonia is added to the washing water.

At this stage of the manufacturing process enter the dyeing and sizing processes, which we describe at the proper place under the caption of "Dyeing and Sizing of Fustian, Beaverteen, or Moleskin."

The dyed, sized, and dried pieces being returned, they are soaped in order to loosen the film which is pasted together by the glue size, and to render them elastic and full to the touch. The soaping is done upon a sizing machine with ductor, or better yet, a machine by which the size is applied to one side only. For this bath, 3 pounds Marseilles soap, or any other absolutely neutral white soap, are dissolved in 50 liters boiling soft water, passed through a sieve, and when lukewarm, enough of the solution is introduced into the

trough of the machine to wet the lower roller. The material is entered the right side down and following the grain, and is given one passage, in which care must be taken that no creases are produced in the cloth; it is then lightly teaseled, without previous drying, and after teaseling, dried. Finally, the fustian is given the perfection of its solid appearance and full, soft touch by shearing, which depends in a great measure upon the exact construction of the shearing machine, among which double cylinder and round table machines are considered to be the best adapted.—*Textile Colorist.*

UTILIZING THE BY-PRODUCTS FROM COKE OVENS.

By Dr. C. OTTO, Dahlhausen, Ruhr.*

IT is long since attempts have been made to construct coke ovens in such a manner as to produce not only coke, but also to utilize the by-products of coking. The first coke ovens on this system were built in France in 1862, while England and Germany have only begun within the last few years to construct coke ovens with extraction of the by-products. To my own knowledge, about 150 coke ovens in France and 50 in England are now working on this principle. In Germany there are now working 190 of these ovens, which number will be increased in a short time to 390. I comply with the desire of your president by describing in this paper a system of coke ovens designed for the extraction of the by-products, of which ninety are working in Germany, while 200 more are about to be constructed. In Austria, again, thirty of these ovens will shortly be set to work. The inventor of the system in question is Herr Gust. Hoffmann, of Gottesberg, in Silesia. Its essential features consist in the combination of coke ovens with the Siemens regenerator, in order to heat the air serving for the combustion of the gas to as high a degree as possible. The temperature necessary to maintain the coking process is obtained in common coke ovens by the combustion of the gases evolved in the interior of the oven, or of its side flues, the hot gases being burnt in the immediate proximity of their place of origin.

The coke oven illustrated by Figs. 1 and 2 on this page has no direct communication between the coking space and the side flues. In fact, except the openings for charging, FO, and for discharging the oven, which are closed during the coking process, there are only two openings, GA, in the roof of the oven by which the gases escape. The side wall of the coke oven contains, under the abutment, a horizontal canal, which passes over the entire set of vertical flues, and is the means of communication between these side flues. Every bottom flue is divided across its length by a partition wall into two equal lengths, SK_1 and SK_2. Each of these lengths communicates with a regenerator, which serves for heating the air destined for the combustion of the gases. SK_1 communicates with LR_1, and SK_2 with LR_2.

These regenerators are long flues filled with fire-bricks on the Siemens regenerative plan, in order to obtain a great surface. They extend below the whole of the coke ovens, and communicate at one end, by means of a clack valve, either with the pipe conveying air or with the chimney. On two sides gas-pipes are placed along the battery, of which I will speak immediately. Imagine, now, that the ovens are hot, and that the coking process is going on. The gases from the coal escape by the openings, GA, in the roof of the oven into the rising pipes, SR, and into the receiver, VL. The valve, V, placed between the rising pipe and the receiver, by which the communication between the oven and the receiver can be interrupted, is now opened. From the receiver, VL, the gases go the condensation house, where they are cooled and washed by different apparatus. The gases returning from the condensers, where they have lost their tar and ammonia, are forced back to the ovens through the gas pipe GDR, by the same exhauster which had sucked them to the condensers, and by means of which the whole motion of the gases is caused.

According to the position of the clack valve in the gas pipe, the gases enter now either into the gas pipe on one side or into the gas pipe on the other side of the oven. The bottom flue of every coke oven communicates with the gas pipes by means of a nozzle pipe furnished with a tap. Assume that the clack valve, inside the gas pipe, is placed in such a manner that the gas goes to the gas pipe, GDR_1, then the clack valve, W, of the air regenerators must be placed so that the air is forced by a fan into the air regenerator, LR_1. The air regenerator, LR_1, and the nozzle pipes of the gas pipe, GDR_1, discharge at every coke oven into the bottom flue, SK_1. In this manner gases and hot air enter into the bottom flue, SK_1. The combustion of gases takes place first in the bottom flue, and continues in the side flues. The whole current of the burning gases and of the very hot products of combustion rises by the parallel side flues, VZ_1, into the horizontal flue, HK, and thence falls down through the side flues, VZ_2, into the bottom flue, SK_2, whence the gases, which may now be considered as completely burnt, pass through the air regenerator, LR_2, and then escape through the chimney, delivering their heat to the lattice work of the air regenerator on their way. After a certain time, say about an hour, the position of the clack valves in the gas pipe and in the air flue are changed, so that the direction of the gas and air is reversed.

The gases escape out of the gas pipe, GDR, into the pipe, GDR_2 while air enters into the air regenerator, LR_2. Combustion takes place in the bottom flue, SK_2, and the current of gases, air, and products of combustion passes through VZ_2, HK, VZ_1, SK_1, and the air regenerator, LR_1, into the chimney. In this manner the current of gases passes alternately in the two directions through the bottom flue and side flues of the coke oven, whereby a remarkably even temperature is obtained in the oven. The heat of the products of combustion is for the most part absorbed by the regenerator for heating air, which attains a temperature of 1,800 deg. F. In one of our German coking works we produce per coke oven per day 24,700 cubic feet of gas, whereof we require for the coking process only 17,700, so that we have a surplus of 7,000 cubic feet of gas per oven per day. The bottom flues and side flues are so extremely hot that with a charge of 5 tons 13 cwt. of dry coal the coking process lasts only forty-eight hours, or the same time as in coke ovens without extraction of the by-products. In general, we have it in our hands to regulate the temperature of these coke ovens by augmenting or reducing the quantities of gas and air, which can be exactly adjusted. The quality of the coke is at least equal to that which we obtain in the ordinary coke ovens. The yield of coke in coke ovens with extraction of the by-products is always several per cent. higher than in common coke ovens, on account of the air-tightness of the charging and discharging openings, and a slight pressure of gas in the ovens. We have proved the following temperatures:

	Deg. Fah.
In the bottom flue	2200–2550
In the side flues....	2000–2200
In the regenerator, when the current of air was first admitted..............	1800
One hour afterward...................	1330
In the chimney.......................	800– 932

The drawings represent a coke oven with vertical side flues. This construction finds great favor in Germany, because the arrangement of the bricks makes it possible to give very small dimensions between the side flues and the coking space. Ordinarily we make these wall bricks $3\frac{9}{16}$ in. thick; by way of trial we have even diminished this thickness to $2\frac{3}{4}$ in., and we have found that in the latter case the coking is completed several hours sooner than in the former. The combination of Siemens regenerators with coke ovens is independent of the construction of those ovens, and can be applied to coke ovens on other systems.

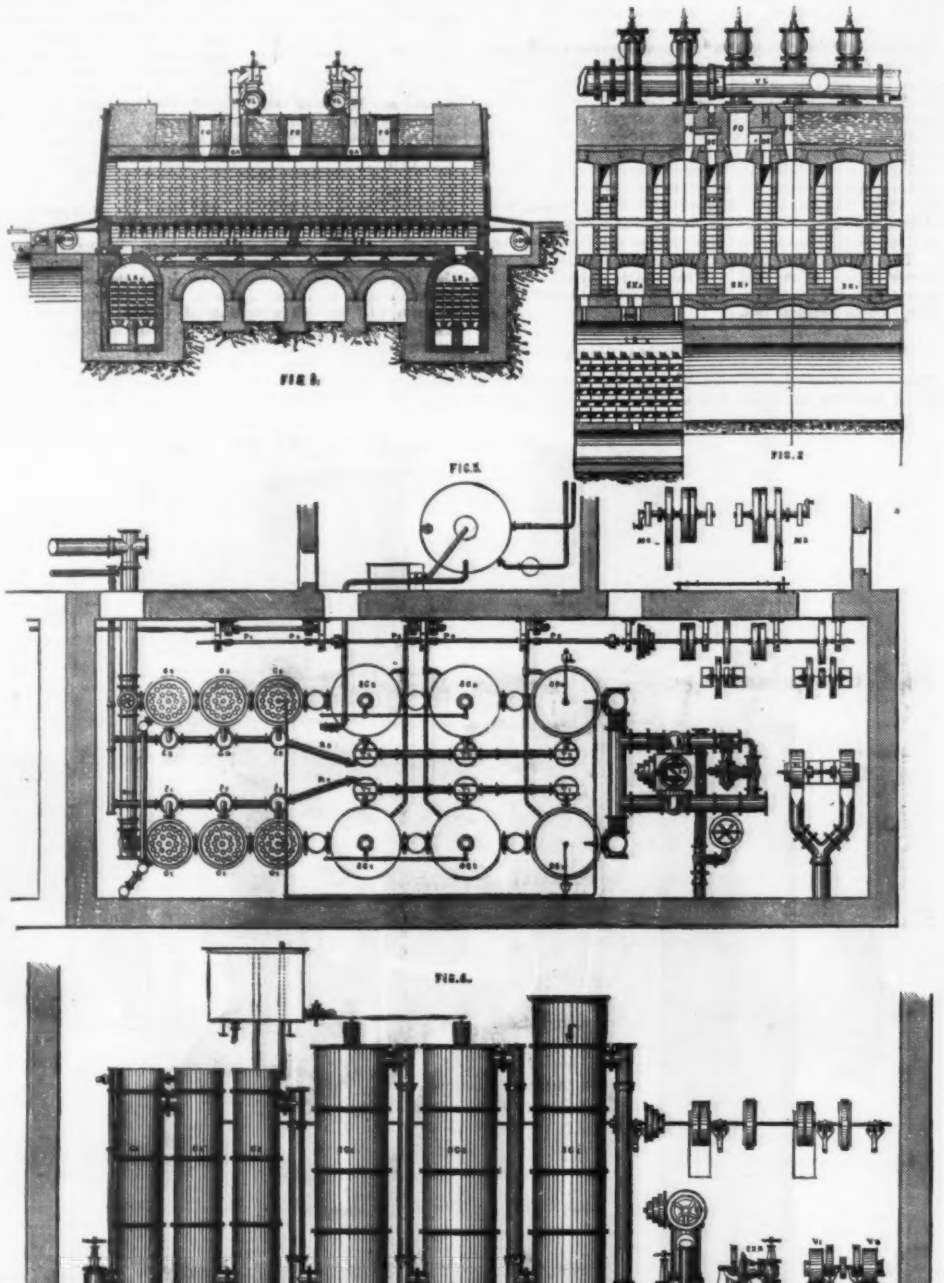
The coolers, Figs. 3 and 4, are vertical iron cylinders closed at each end, in which are vertical iron tubes fastened to the top and the bottom, and open at each end. Above the cover is placed a cylindrical iron reservoir. The water flows through the tubes, while the current of gases passes outside them in the opposite direction. These coolers have a cooling surface of 5·72 square feet, 1,000 cubic feet of gas passing through. To the coolers now in construction we give as much as 7·6 square feet of cooling surface for every 1,000 cubic feet gas, having found that a great cooling surface is very advantageous for condensation. Condensers placed behind coke ovens must have a cooling surface proportionally greater than those of gasworks, because the production of gas in coke ovens is less regular than in retorts. We have measured the temperature of the gas after it passes out of the coke oven, and we have found:

	Deg. Fah.
In the rising tubes...........	1200–1300
In the receiver (according to the distance from the oven............	400– 750
Before the coolers...	170– 250
Beyond the coolers....................	66– 85

Our washers, Figs. 3 and 4, are vertical cylinders of cast or wrought iron, in which a great number of perforated plates are placed horizontally over one another. A continual stream of cold water trickles down upon the uppermost plate and through it to the others, so that from plate to plate a rain of drops is constantly passing in the opposite direction to that of the gas, the latter in its upward passage giving up to the water the ammonia which it contains. The washers retain the whole of the tar and ammonia not yet condensed in the coolers. If we have cold enough water at our disposal, the temperature of the gas will be lowered in the washers to 55 deg. Fah. Our washers offer to the gas a surface of 7·8 square feet to every 1,000 cubic feet gas.

Figs. 3 and 4 show a condensing apparatus sufficient for twenty coke ovens. The gas comes out of the ovens through the gas pipes, GAR. Then one-half of it passes through the three condensers, C_1, and through the three scrubbers, SC_1, while the other half goes through the three condensers, C_2, and the three scrubbers, SC_2. Beyond the scrubbers, SC_1, and SC_2, the two halves unite and pass through the exhauster, EX, which forces the gases through the gas pipe, GDR, back to the coke ovens. EXR is a spare exhauster. The air of combustion is forced in by the fans, V_1 and V_2, the second of which is kept as a reserve. P_1, P_2, P_3, P_4, and P_5 are small pumps for tar and ammoniacal liquor. M_1 is the driving engine; M_2 is a spare engine. The condensers, C_1, let fall tar and ammoniacal liquor into the vessels, t_1, and the condensers, C_2, into t_2. The products of condensation deposited in the scrubbers, SC_1, run into the vessels, T_1, and those in SC_2 into T_2. Out of the vessels, T_1, t_1, and T_2, t_2, tar and ammoniacal liquor run through the pipes, R_1 and R_2, into a tank situated outside the condensation house, out of which tank they are raised, when required, by small pumps into another tank above the gas coolers.

The gain of ammonia, counted in sulphate of ammonia, amounts in Westphalia to 1 per cent. of the weight of dry coal put into the coke oven. This gain corresponds exactly with the contents of ammonia as ascertained by analysis. The quantity of ammonia contained in the coal varies in different districts, and even in the same coal district. In the Saarbrucken district the coal yields only 0·7 to 0·8 per cent. of sulphate of ammonia, whereas this figure rises in Upper Silesia to 1·1 to 1·7 per cent. The yield of tar at one of our coking establishments amounted in seven months to an average of 3 per cent. on the dry coal put into the coke ovens. The tar contains less benzine than that produced in gasworks, but the amount of naphthaline and anthracine



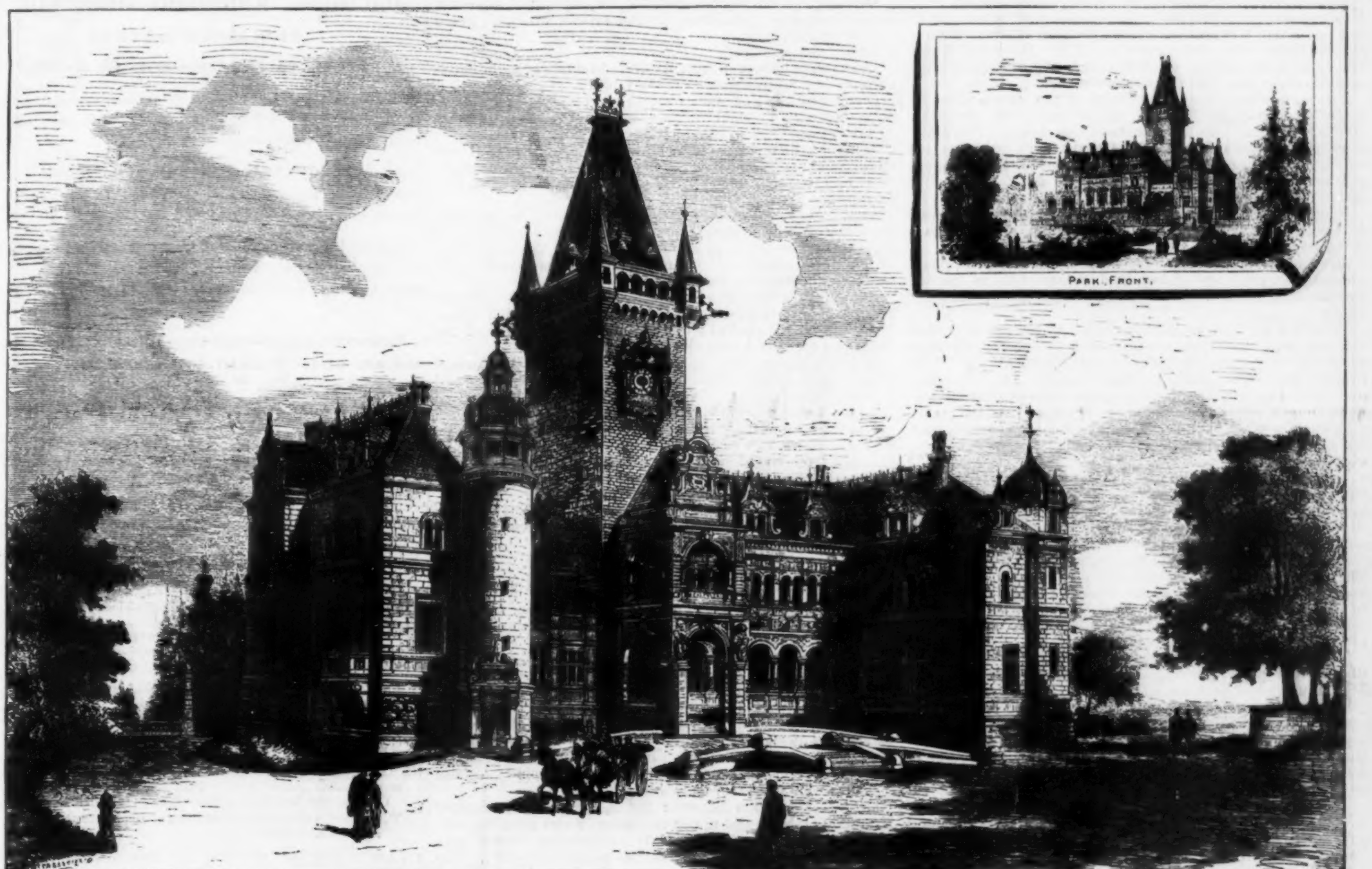
HOFFMANN'S REGENERATOR COKE OVENS.

* Iron and Steel Institute.

which it contains is equal to that contained in gas tar. We have analyzed the gas produced during the coking process after its passage through the condensers. It contains a smaller amount of light-giving elements than the gas supplied by gasworks; in other respects its composition is the same:

	Volume per cent. of the dry gas.
Benzine vapor	0·61
Athylene	1·63
Sulphureted hydrogen	0·43
Carbonic acid	1·41
Carbonic oxide	6·49
Hydrogen	53·32
Methylene	36·11
	100·00

I have already said that the gas which returns from the condensers is not all used in the coking process. The surplus can be converted into money. By the use of very large burners it can be applied to purposes of illumination in factories, iron or coal works, or for heating boilers, etc. For heating purposes it has the great advantage that it can be conducted to very great distances without suffering in quality. We have ascertained that by the daily combustion of 2 tons 14 cwt. of coal per oven, we can depend upon obtaining sufficient waste heat from every oven to heat 54 square feet of boiler surface. A heating surface of 54 square feet per coke oven corresponds with an evaporation of 1 lb. of water for every pound of coal coked. I cannot say whether or not these figures are surpassed by English coals. They refer to trials made with Westphalian coal, and can therefore be compared only with results obtained with those coals. In Westphalia, with an ordinary coke oven without extraction of the by-products, containing 5 tons 18 cwt. of coal, we heat 80 square feet of boiler surface, or we evaporate 1½ lb. of water by every pound of coal coked. We see, then, that the gas produced by coke ovens loses less heating power in its passage through the condensers than we might have supposed, and that we can not only extract the by-products, but also heat boilers with the gas which has undergone this process, together with the highly heated products of combustion which have passed through the air regenerator.



SUGGESTIONS IN ARCHITECTURE.—CASTLE HUMMELSHAIN, NEAR KAHLA, THURINGIA.

CASTLE HUMMELSHAIN, NEAR KAHLA, THURINGIA.

IN the beginning of 1872 a part of the Duke of Sachsen-Altenburg's hunting-castle Hummelshain, situated about seven miles from the city of Kahla, on the Saale, was destroyed by fire; and at the time the Duke had the intention of immediately erecting an entirely new castle. Matters were delayed, however, until the year 1880, and the building was completed this year. The imposing new building is located on one of the highest points of the beautiful park. It was designed by the architects Ihne and Stegmüller, of Berlin, and Kluge, of Altenburg. The style is a noble German Renaissance, and the material used is sandstone.

The main cut shows the north and main front, with the portal, the porte-cochere and the main tower, and the smaller cut, in the upper right hand corner, shows the south elevation, with the grand staircase, the terraces, and fountain. The heraldic animals on the portal, carrying the coats of arms of Sachsen-Altenburg and Anhalt, and the magnificent copper dial plate of the clock held in an elegant frame flanked by standard-bearers, are worthy of special mention.

The exterior decorations of the castle are very elegant and elaborate throughout, and the interior has been treated in the same manner. From the main portal a marble vestibule is reached, which leads to a reception room, to the right of which the rooms of the Duke are located. The round staircase building is ornamented by fresco paintings representing the four seasons, by Prof. Schaller, of Berlin. The staircase building at the left, where the rooms of the Duchess are located, contains a large fresco painting representing the "Life of Diana," also by Prof. Schaller. The grand hall is ornamented by panelings of oak and stained glass windows, and the walls are ornamented by paintings, by Prof. Friedrich, of Weimar, representing hunting scenes; and above the cornice are pictures of castles, paraphernalia of the hunt, fishing, agriculture, etc.

From the top gallery of the tower a beautiful view can be obtained of the surrounding country and the cities of Leuchtenburg and Jena, the well-known university city, and of the extensive mountains and forests of Thuringia.

The accompanying cuts are taken from the *Illustrirte Zeitung*.

INFLUENCE OF LIGHT ON THE DEVELOPMENT OF YEAST.

THIS has been the subject of some interesting experiments by M. Kny. He placed some pressed yeast in a liter of nutritive liquid containing 100 grammes of sugar, 2·5 grammes of asparagine, and 20 c. c. of solution of mineral salts (50 grammes of phosphate of potash and 17 grammes of sulphate of magnesia per liter), and he then placed equal quantities of the mixture, one under a blackened bell jar, and the other under a clear, transparent bell jar exposed to the light of a powerful gas jet. The caloric rays were arrested by a layer of water, so that the temperature of the two liquids did not vary one-tenth of a degree. In each case the number of yeast cells was counted at the commencement and termination of the experiment by the known method. As different countings often give different results, the experiments were continued by another one in which only a single cell was introduced. From the mean results of some eight experiments, it was found that the multiplication of the cells had been in three cases somewhat greater under the dark bell glass, and in five cases rather greater under the transparent glass, so that the differences almost balanced each other exactly. From the result of these experiments it would appear that the cells of Saccharomyces cerevisiæ develop with equal rapidity under the influence of light as in the dark.

PREPARATION OF MALTOSE.

IN a recent paper Cuisinier describes Dubrufut's method of obtaining maltose, with the modifications necessary on the large scale. The maltose can be prepared either in crystals or as sirup.

1. *The Water* must be free from suspended impurities and organic matter, and should contain neither carbonate nor sulphate of lime, the former promoting butyric fermentation, and the latter interfering on evaporation. Distilled water is accordingly recommended.

2. *Raw Material.*—For crystals: starch in the purest condition; for syrup: meal, potatoes, grain, the latter being coarsely ground.

3. *Preparation of the Malt.*—In the manufacture of crystallized malt, malt itself is not used, because some of the little known substances which it contains have a deleterious influence on the crystallization. An aqueous infusion made at 30° is accordingly employed. The malt must be dried at a low temperature, or green malt may be used. Instead of barley, other malted grains may be used.

4. *Solution of the Starch.*—The starch is made into a paste with twice its weight of water, and, after an addition of an amount of extract equal to 5 per cent. of malt, is thoroughly mixed. An amount of water equal to ten times the weight of starch is heated to 90° C. (194° F.), and the two liquids allowed to flow simultaneously through a peculiar sieve. The solution is ended by blowing in steam. Temperature of the mixture on entering the boiler, 75° C. (167° F.). The mass is as mobile as water at 90°, and the operation may be considered at an end.

5. *Saccharification.*—The fluid is conveniently cooled to 40 (C. 104° F.), and treated with an amount of malt extract equal to 10 to 15 per cent. of malt on the original starch. The temperature during saccharification is maintained between 40° C. (104° F.) and 50° C. (122° F.) The progress is ascertained by means of iodine solution, and in the preparation of crystalline sugar also by the alkaline copper solution. After two or three hours the fluid no longer gives a color with iodine, and in the manufacture of sirup the process may be stopped; if solid maltose is required, the operation must be continued for twelve to fifteen hours.

6. *Filtration and Concentration of the Liquor.*—When only starch is employed, filtration is sufficient to separate the fluid from the residue; but when rice, maize, etc., are used, a preliminary pressing is necessary. The fluid, passed through an Oldham-Farquhar filter, indicates 4° B. (1.027); it is then concentrated to 20 B. (1·152), and the now yellowish juice is allowed a fixed time for cooling and settling. It is next filtered cold, some of the separated flocculent albuminous bodies being soluble on warming; it is next filtered through animal charcoal, running off clear and colorless. The evaporation is now carried on to 40° B. (1.357) in copper vessels. Solid maltose, containing 80 per cent. of sugar, is distinguished from glucose by not being hygroscopic, has a very agreeable, sweet taste, and an aromatic odor. The sirups mix without turbidity with water in all proportions, time showing no influence on their transparency.

THE FUSION OF IRON.

IN the *Metallarbeiter* there recently appeared some observations on the behavior of iron in smelting and casting. It was pointed out that the metallurgical processes by which iron is extracted from the ore produce at the first running a metal which is chiefly iron, but which also contains carbon, silicon, manganese, and other subtances. These are impurities; but they have their uses in lowering the melting point of the metal. Pure iron, from its very high fusing point, is not well adapted for foundry use. The pig iron, with its high percentage of carbon, is much more convenient for castings. When pig iron is remelted in a cupola, air is brought into contact with the metal and the carbon mixed with it. Part of the carbon is oxidized, and the other impurities, such as silicon and manganese, together with a small quantity of iron, are oxidized and drawn off as slag. Other products of oxidation, carbonic oxide and iron oxide, are dissolved in the molten metal. The aqueous vapor of the air employed in the cupola blast is decomposed into oxygen and hydrogen; the first of which goes to oxidize the fuel and metal, the latter is dissolved into the metal. Iron possesses the property of absorbing, in the molten state, three times its volume of hydrogen. As the metal cools, the occluded gases (hydrogen and carbonic oxide) are set free; leaving traces of their presence in the spongy, porous surface frequently found in solidified masses of metal. When molten iron, containing these gases, is run into a mould, the gases are liberated in the casting. This is especially the case where the metal is run at a low temperature. The gases are best eliminated by making the iron very hot, and

stirring it well in the ladles before filling the moulds. Iron when remelted has a greatly increased power of absorbing gases and iron oxide. For homogeneous castings it is necessary that all pig iron should be used, without admixture of old castings. Spongy castings are also caused by an improper moulding material, which leads to the formation of surface cavities. The bubbles produced by dissolved gases, however, have a bright, metallic surface, while those due to the moulds are covered with a dull film of oxide.

THE VAPORS OF METALS.

THE SPECTROSCOPIC EXAMINATION OF THE VAPORS EVOLVED ON HEATING IRON, ETC., AT ATMOSPHERIC PRESSURE.*

By Mr. JOHN PARRY, Ebbw Vale.

METALLURGISTS favored with opportunities of observing the behavior of metals while being heated or fused are of opinion that the fumes usually seen are due to the volatilization of the metal itself, or of some more volatile constituent.

In casting alloys of the more fusible metals, this dissociation or volatilization is an accepted fact, and is usually considered when adjusting the proportions of the constituents. Alloys of the more infusible metals, such as iron, manganese, nickel, cobalt, etc., have not been studied, but those who have observed the behavior of crude iron and steel while being fused, or otherwise manipulated at high temperatures, have noted that, in addition to the well known evolution of gas, fumes are given off, which has led to the inference that, as before stated, some more volatile constituent is being evolved; and Professor Ledebur asserts that even iron is volatilized. The chemical composition of a metal may therefore be changed, presumably, within certain narrow limits. It may be that crude iron is slowly dissociated, and certainly at the high temperature of the Bessemer process iron is volatilized, and may be seen far above the mouth of the converter, forming a red cloud, quite unlike ordinary smoke or vapor.

The spectroscopic examination of the flames issuing from blast and other furnaces shows only continuous spectra, with but few lines, very similar to the spectrum of the ordinary Bunsen flame, with the exception of the Bessemer flame, which gives the carbon spectrum, together with (according to some observers) that of manganese.

I have, however, found that many of the metals are volatilized at a comparatively low temperature, but give only continuous spectra when examined in the flame. The vapor requires the intense heat of the electric spark to be passed through it to insure complete dissociation, and consequent production of the usual line spectra. (A list of metals thus tested is given below).

Spiegeleisen fused in a crucible evolved a fume in which I detected zinc, copper, manganese, calcium, and with less certainty, magnesium.

Bessemer pig iron, similarly treated, gave copper, manganese, calcium, and either lead or arsenic, as well as gas burning with a flame resembling that of carbonic oxide.

Bessemer pig iron burnt in a stream of oxygen at a dull red heat gave copper, manganese, etc., as before, but more intensely; also a great number of lines which appear to be derived from iron. This spectrum requires careful study, and, when developed, may throw some light on the reactions occurring during the Bessemer blow.

Spanish iron ore reduced in a crucible with charcoal, at a heat sufficient to form a button of fused metal, evolved zinc, copper, and manganese.

It is therefore probable that matter may be evolved during the ordinary heating processes in the manufacture of iron and steel, as previously explained, but giving no visible indications of the fact, in consequence of the heat being sufficient only to volatilize without effecting dissociation.

With my present limited experience, I am of opinion that the actual quantity of matter evolved from iron, steel, etc., is very small, and not at all likely to affect the quality of the coarser kinds of iron and steel, although it may be otherwise when a material of even quality and great purity is required.

The germ of the foregoing is to be found in the recent work of spectroscopists, more especially of Mr. Lockyer, who, in his "Studies of Spectrum Analysis," a volume abounding with suggestions which should, in my opinion, be carefully studied by those practically engaged in the iron manufacture, says: "Depend upon it, that as spectroscopy becomes the daily work of ironfounders and the like, it will be found to be bristling with scientific truth which may be used in these practical applications."

Notes.—Spanish iron ore evaporated to dryness with hydrochloric acid. The dried chlorides were carefully and gradually heated in the blowpipe, and copper, zinc, calcium, barium, lead, silver, and manganese lines successively detected in volatilized chlorides. At the highest obtainable heat, iron lines are seen.

The impure ferric chlorides, obtained by digesting steel or iron in hydrochloric acid and evaporating to dryness, heated as above, show, first, copper and calcium; second, manganese; next, with less certainty, chromium and magnesium. On increasing the heat, the iron spectrum is vividly seen.

Steel or iron filings, mixed with ammonium chloride, and heated also, gives the foregoing series of spectra, which last longer, and may be repeated by successive additions of the chloride.

Very fine spectra of sulphur and phosphorus may be obtained by slightly heating either, on a moderately hot plate of iron, placed just below the spark from the coil. None of the lines have been detected in the fumes evolved from iron and steel.

Notes on the Volatility of the Metals in Heated Crucibles. Fletcher's "Injector Blowpipe," Used.

Thallium	Very volatile.	Flame and spark spectrum.
Arsenic	"	Spark spectrum.
Copper	"	Volatilized from most metals. Flame and spark found in most metals.
Cadmium	Easily volatilized.	Spark spectrum only.
Zinc	"	"
Bismuth	Volatilized at highest red heat.	Ditto.
Antimony	Easily volatilized.	Ditto.
Potassium	"	Flame and spark spectrum.
Sodium	"	Ditto.
Tin	Volatilized at highest temperature of blowpipe.	Spark only.
Lead	Volatilized at lower temperature than tin.	Ditto.
Silver	Not volatile.	Copper spectrum seen. Ditto.
Gold	"	" "
Chromium	"	" "
Manganese	Volatilized with difficulty.	Ditto.
Aluminum	Volatile	
Selenium	Very volatile.	Spectra require further study.
Tellurium	Ditto.	
Phosphorus	Easily volatilized on hot plate.	Good spark spectrum.
Sulphur	Ditto.	

Notes of Experiments on the Spark Spectra of the Chlorides of the Metals and Alkalies volatilized at Atmospheric Pressure.

The chlorides of lithium, strontium, copper, and calcium are volatile in the flame of an ordinary alcohol lamp, showing the characteristic spectral lines in the spark about 1 in. above the flame.

Zinc, barium, copper, and magnesium chlorides are also faintly seen. Query about arsenic? Filter paper moistened with zinc chloride and placed in the alcoholic flame gave the line W. L. 4809.

Steel filings mixed with ammonium chloride and heated, copper and manganese first appear, next calcium (zinc?), next iron spectra; after heating thirty minutes only, one copper and two manganese lines are seen. Iron lines nearly gone; calcium seen. Further heated thirty minutes, only calcium; traces of copper flashing out.

Spiegeleisen as above; in addition, magnesium seen; brighter spectrum throughout.

Sulphur heated on plate with spirit lamp, spark above gave vivid spectrum of sulphur. Phosphorus as above.

Copper chloride mixed with ammonium chloride and heated with spirit lamp in a glass tube 20 in. long, copper distinctly seen in the spark at the top of the tube.

Impure steel chlorides, as above, heated in glass tube 4 in. long, spark at top, calcium first seen, copper, next manganese group. After heating some time, only calcium and copper were visible.

Ordinary nickel, cobalt, bismuth, tin, and antimony show copper spectrum when heated. All metals hitherto tested evolve copper.

Query zinc in steel?

Query magnesium in spiegel? Only first line of magnesium seen on edge of nitrogen line, W. L. 5712.

Compared this line with magnesium, by clamping cross wires down on it; magnesium line distinctly seen on edge of nitrogen, W. L. 5712.

It may be inferred from the results herein given, and from those previously published in the *Journal* of the Institute, that the foreign elements present in iron may be divided into two groups:

First, alloys, solidified solutions of one metal in another, such as iron with hydrogen, carbon or combinations of iron and hydrocarbons, copper, manganese, etc. These are more or less dissociated in accordance with the temperature and time of exposure to a given heat.

Second, other combinations with iron of which sulphur and phosphorus may be considered typical, in which dissociation is not effected at a temperature less than that of the induction coil spark and electric arc.

A third group may be imagined in which the foreign element (according to Deville) is intermolecularly dispersed throughout the metal. Carbonic oxide may thus exist in iron and steel.

I venture, therefore, to suggest that, in addition to the ordinary estimation of carbon, sulphur, phosphorus, etc., in iron and steel, the amount of iron oxide should be determined, and the hydrogen and carbonic oxide evolved on heating *in vacuo* (at a certain fixed temperature to be hereafter determined), should be given in volumes of the metal tested; in other words, that one cubic inch of metal evolved by cubic inches of hydrogen and carbonic oxide.

* Paper read at the Chester meeting of the Iron and Steel Institute.

THE GEOLOGICAL STRUCTURE OF THE SAHARA.

DR. K. A. ZITTEL has published the following facts and conclusions as the preliminary result of his explorations in the Libyan Desert:

The Sahara is distinguished by an exceedingly simple geological structure, by the horizontal position of most of the sedimentary rocks, and by the absence of faults. To the southern slope of the Atlas in Morocco, which forms the northern boundary of the Sahara, there are joined palæozoic formations (carboniferous and Devonian), upon which follow, further to the south, sandstones, palæozoic slates, sometimes interpenetrated by granite and porphyry, as also quartzite and azoic clay-slate.

In the depression between the Atlas and the Ahaggar Mountains middle and upper cretaceous rocks form the substratum, while quaternary sandy fresh-water clays, with gypsum and rock-salt, constitute the superficial layers. The same cretaceous deposits form the soil of the Hammada el Homra, and of the Harudj Mountains in Tripoli. In the south it is directly followed by Devonian sandstone. The latter, with the underlying limestones and slates, is the predominant formation to the southern limit of the Desert.

Permian, triassic, jurassic, and subcretaceous formations have been hitherto detected neither in the Sahara nor the Egyptian frontier mountains. The great plateau-mountains of Ahaggar in Air and Tibetsi seem principally to consist of palæozoic sandstone, clay-slate, gneiss, granite, and recent eruptive volcanic rocks. Tertiary deposits of marine origin are to be found only to the north of the Chotts of Tunis. They occur also to a considerable extent in the Libyan and Arabian Deserts. In the north-eastern Sahara and in Egypt the eocene nummulitic rocks extend southward o the latitude of Esneh; the miocene rocks have their southern limit at the oasis of Sinah, and the hills between Cairo and Suez.

The southern and a part of the central Sahara have been dry land since the end of the Devonian period; the greater part of the remaining Sahara was left dry after the cretaceous epoch. The sea still maintained itself in the Libyan Desert during the eocene, and in the northern part of that region down to the middle miocene.

The eruptions of the basaltic, phonolithic, and trachytic rocks in Tripoli, the Libyan and Arabian Deserts, as also probably those in the mountain-lands of Ahaggar and Tubu, occasioned but little disturbance in the adjacent formations, and must have ensued chiefly in the later tertiary times.

During the diluvial period the Sahara, as well as a part of the southern and eastern Mediterranean, was dry land. The hypothesis of a diluvial Sahara sea is confirmed neither by the geological structure nor the surface appearance of the Desert. At the utmost the region of the Tunisian Chotts may have been connected with the Mediterranean, and perhaps the narrow depression between Alexandria and the Ammon oasis with the Red Sea.

During the diluvial period there prevailed in North Africa a moist climate, which probably continued until the beginning of the present epoch.

The characteristic formation of the surface of the Desert, the elaboration of many dry valleys, the formation of basin-shaped depressions, the origin of steep banks, insulated mountains, etc., are due to the erosive action of fresh water.

The sand of the Desert has been produced by the decomposition of sandstone, which predominates everywhere in the middle and southern Sahara. Its distribution and accumulation in dunes has been effected by the wind.

The salt-marshes, and the saline and gypsiferous superficial deposits, have been formed by the evaporation of waters which had collected in the hollows. There is no proof of any essential change in the climate of the Sahara during the historical period.—*Jour. Science.*

A PETROLEUM ENGINE.

AN electro-petroleo motor, in which an extra current spark is made to ignite the explosive mixture, has been invented by Herr Siegfried Marcus, of Vienna. Inside the chamber where the explosion is to occur, the ends of the coil wires, between which the spark is produced, slide over each other, the action being regulated in accord with the rotation of the magneto-electric apparatus, the ends of the wires being in contact while they are magnetized and separating at the moment of demagnetization or change of polarity, producing the extra current spark.

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